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ABSTRACT

The EDC (Educational Development Center) Center for Children and Technology (CCT) and Computers for Youth (CFY) completed a 1-year comparative study of children's use of computers in low- and middle-income homes. The study explores the digital divide as a literacy issue, rather than merely a technical one. Digital literacy is defined as a set of habits through which children use computer technology for learning, work, socializing, and fun. The study answers the following questions: What kinds of digital literacy are emerging for children in low- and middle-income households where there is access to computers and the Internet, and why? The paper summarizes comparative findings in each of the following dimensions of literacy, and examines why these patterns have emerged: troubleshooting; purposes driving children's computing in low-income households are primarily; common tools; communications literacy; and Web literacy. Nine low-income urban children and 10 middle-income suburban children participated in the study. All were in the seventh or eighth grade and had at least one Internet-connected computer in their home. As a group, they represented a range of educational achievement levels and a diversity of demographic backgrounds. An appendix presents two brief profiles of The Academy for Scholastic Excellence (ASE) and The Power through Arts and Community (PAC) School. (Contains 15 references.) (AEF)

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CCT REPORTS
FEBRUARY 2002

CHILDREN'S EMERGING DIGITAL LITERACIES:

INVESTIGATING HOME COMPUTING IN LOW- AND MIDDLE-INCOME FAMILIES

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EXECUTIVE SUMMARY

The EDC Center for Children and Technology (CCT) and Computers for Youth (CFY) have completed a one-year comparative study of children's use of computers in low- and middle-income homes. We explore the digital divide as a literacy issue, rather than merely a technical one.

We define digital literacy as a set of habits through which youngsters use computer technology for learning, work, socializing, and fun. The study answers the following question: What kinds of digital literacy are emerging for children in low- and middle-income households where there is access to computers and the Internet, and why?

Methods

Nine low-income urban children and ten middle-income suburban children participated in the study. All were in the seventh or eighth grade and had at least one Internet-connected computer in their home. As a group, they represented a range of educational achievement levels and a diversity of demographic backgrounds.

The low-income children each attended one of CFY's partner schools, in which all students and teachers had received a CFY home computer, training, ongoing technical support, email accounts, and tailored web content. The middle-income children each attended one of two schools and had acquired their home computers on their own.

CCT researchers made two to three home visits per family. Visits lasted approximately two hours and were conducted between the months of November 2000 and July 2001. Data were analyzed along five dimensions of digital literacy: purposes of computing, troubleshooting, fluency with common applications, communications literacy, and web literacy.

Key Findings

We found that all the children in the study use their computer to do schoolwork. Many children with leisure time at home also spend two to three hours a day communicating with peers, playing games, and pursuing creative hobbies. When solving technical problems, the low-income children rely more on formal help providers such as CFY and school teachers, while the middle-income children rely more on themselves, their family, and peers. Overall, we found that all the children in the study developed basic literacy with word processing, email, and the web. Those children who

spend considerably more time online develop more robust skills in online communication and authoring.

We found that children's digital literacies are emerging in ways that reflect their local circumstances. In each community, children's home computing practices are strongly influenced by their technological, social, and school environments. Regarding the technological environment, we identified three elements that impact how children use their home computer:

- **The length of time children had a computer at home.** Middle-income children have more comfort and confidence in using their home computers because they have been present in their homes for a considerably longer time.
- **A family's ability to purchase stable Internet connectivity.** Credit cards make it easy for middle-income families to purchase Internet access. Low-income families without credit cards need to find providers that accept other forms of payment, which CFY assists them in doing.
- **The number of computers in the home and where they are located.** Low-income homes usually have only one computer located in a heavily trafficked area, such as the living room or kitchen. As a result, the children's activities are more likely to be shared with the family and supervised so as to encourage use of the computer for educational purposes. Middle-income homes, in contrast, often have more than one computer and children are more likely to use it alone in a private area such as a bedroom. As a result, there is less social interaction around the computer and children use them more for recreation rather than educational purposes.

We also identified five elements of children's social environment that shaped their computing:

- **Parents' attitudes toward computer use.** There is little difference in attitude between low- and middle-income communities. Most parents believe that home computer use help their children succeed in school and they create rules that encourage their children to put homework before fun. In the low-income households, parents also perceived their CFY computers as keeping their children home and off dangerous streets.
- **Parents' own experience and skills with computers.** Middle-income parents who have developed extensive computer skills through their jobs and schooling are able to model rich and varied uses of the computer, and engage their children in critical talk about the web. Many of the low-income parents, who had never before touched a computer, were less able to model computing practices for their children. Instead, they supported their children's computing by suggesting certain activities, many of which were cultural and brought family members together.
- **Children's leisure time at home.** The middle-income children have more leisure time at home and are able to develop more skills and use their computers for varied purposes. Besides homework these children also use the computer for fun and social interaction. In contrast,

almost all of the low-income children in this study, because of their school's extended-day schedule, have very little leisure time (most of which is supervised) and use their computer primarily for schoolwork.

- **The computing habits of children's peers.** Children's online communication usually depends on what their peers are doing. The middle-income children primarily use Instant Messenger (IM), while the low-income children mostly use email. Low-income children, however, as they discover IMing, are using it more and introducing it to their peers. CFY's strategy of wiring an *entire school community* appears to leverage "peer culture" in helping children foster new communication skills.

- **The technical expertise of friends, relatives, and neighbors.** Middle-income families often have friends, relatives, or neighbors who have strong technology skills and can help them troubleshoot computer problems. Low-income families are less likely to know people with such skills and so turn to schoolteachers and to CFY for help. This finding demonstrates that organizations like CFY are greatly needed to provide crucial technical support to new users in low-income communities.

Finally, we identified two elements of the school environment that helped shape children's home computing:

- **Homework assignments.** In all the schools attended by our participating children, teachers help students develop digital literacy through homework assignments. For example, in the CFY partner schools, teachers assign homework requiring Internet research and give extra credit for typed reports. In the middle-income schools, teachers' assignments are similar except that high-track students often receive more in-depth and inquiry-based assignments (such as stock simulations and web-quests).

- **The direct instruction teachers provide in the classroom.** Children learn computer skills from instruction in their schools. For example, in the CFY partner schools, some teachers provided instruction on MS Word and on using the Internet, while in the middle-income schools, a library-media specialist offered group computer instruction on how to do an Internet search and then evaluate the information found.

Recommendations

Based on our findings, we believe that policymakers and private funders can do a number of things to support children's acquisition of digital literacy. They can:

- Fund programs that provide low-income families with home computers and the skills to use them
- Encourage home computer programs to train parents, not just children, in "computer literacy"
- Insist that home computer programs not only provide technical support to the communities they serve, but help them build their own troubleshooting strategies
- Help schools become aware of the large roles they play in children's computing
- Support schools in using computing tools to strengthen family-school connections
- Fund programs that help parents understand more about the ways they can keep their children safe online
- Support research and programs that can help families in low-income communities maintain consistent Internet connectivity
- Help replicate the CFY model of providing all students and teachers in a school with home computers and comprehensive services
- Fund additional research on understanding the intricate relationship among family income, social capital, and technology use in different social settings.

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INTRODUCTION

Beyond the 'Digital Divide'

For the past several years, policymaking around low-income children's computing has been driven by a conception of a "digital divide" that we find problematic. The term "digital divide" as commonly understood refers to inequities of access to technology, based on factors of income, education, race, and ethnicity (U.S. Commerce Department, 2000). In response, policymakers have funded programs that put poor people of color in both urban and rural communities "next to" technology. Yet it has been far easier to hook up computers than it has been to make them relevant to people's needs, or to help people use them in meaningful, empowering ways. Some researchers have suggested that our hopeful initiatives for improving people's circumstances with technology have not been fulfilled because we have too narrowly constructed the digital divide as a *technical* issue rather than as a reflection of broader social problems (Light, 2001).

Toward a Concept of Digital Literacy

In this study we explore an alternative construction, the digital divide as a *literacy* issue. We believe a literacy framework makes sense because information technologies, like print texts, are pervasive cognitive and cultural tools for manipulating symbols and sharing meanings. As such, they are now ubiquitous in our economic, work, and social life. Indeed, business leaders, policymakers, and educators are in wide agreement that our definitions of literacy must be widened to include skill with digital technology; that children will need the ability to use information technologies in order to function effectively as citizens and workers in the 21st century (CEO Forum, 2001; ISTE, 2001; Lemke, 2002).

To understand digital literacy, we must investigate what happens in the *home*. While literacy skills may be taught in schools or libraries, these skills are practiced and fortified at home. In addition, the experience and knowledge children gain at home as they engage with videogames, handhelds, email, instant messaging, and audio file sharing, may help them understand the grammar of digital media – a construct similar to the way early childhood experiences like drawing pictures, reading cereal boxes, telling stories, and writing notes are the foundations of print literacy.

We must approach literacy practices in the home carefully. Research suggests that literacies are situated in particular practices with children's homes and local communities approaching it in their own ways (Brice-Heath, 1983). For example, Brice-Heath found that in the communities she studied children learned quite different habits of storytelling and language use at home, and that the literacy practices at school drew on some of these habits, but not others. Children developing digital literacy in their homes are likely to do so in ways that reflect their own particular environment and culture.

The literacy framework suggests, therefore, a research program that would look at (a) the kinds of vernacular literacy that children are developing around information technologies in their home

environment, and (b) how this vernacular literacy relates to computing activities around learning, work, and play. In addition, our knowledge that communities approach literacy in their own way suggests a comparative study in both low- and middle- income households that would explore how income, culture, and surroundings play a role in the development of digital literacy.

As it happens, more than 90% of digital divide funding has placed computers in schools, libraries and community centers. Only a handful of organizations like CFY have been focused on providing low-income students and their families with home computers and the skills to use them. The CFY program is unique in its community-centric and comprehensive approach. The program selects public middle schools with high levels of poverty and provides its services to every member of the school community. All students (together with their parents) and all teachers receive a comprehensive package of a home computer, training, ongoing technical support, email accounts on a community-wide system, and tailored web content. CFY's focus on the home is deliberate. They believe that, just like a musical instrument, computers can be taught in school but they are learned at home. CFY's approach of selecting school communities and then serving all the associated families is unusual among home access programs. CFY believes this approach can better strengthen the home-school connection, enable students and teachers to use technology in more intellectually powerful ways, and encourage parents to become more involved in their children's education. In this study, we worked with CFY to investigate how forms of digital literacy are emerging among children from low-income households and those from middle-income households.

Defining Digital Literacy

While there is agreement that a new set of "21st-century skills" involving technologies is important, there is little consensus about precisely what knowledge and abilities are necessary for children to be "information technology literate."

Most definitions of information technology literacy have described skills with specific tools — the ability to use a word processor or a search engine, or configure an input/output device (Adams, 1984; Inskeep, 1982; Gilster, 1997). While such definitions have the virtue of specificity and measurability, they also present problems. First, they quickly become obsolete because of the rapidly changing nature of technology. In the 1970s, definitions of "computer literacy" involved identifying floppy disks and programming in BASIC (Inskeep, 1982), while in 2000 computer literacy includes the ability to unzip a zipped file and upload files to a server (Gilster, 1997). In addition, such tool-dependent definitions typically enumerate countless specific skills, begging the question of whether literacy might entail the development of more general capabilities that people may apply across tools and settings.

If these definitions are too specific, many others are too general, at least for research purposes. Business leaders, policymakers, and educators have sought to view technology-related skills within the wider frame of skills needed for contemporary business organizations, as well as citizenship skills needed for a civil society. The CEO Forum's STaR Report defines digital literacy as a list of basic and intellectual skills "including language proficiency, namely, reading, writing, listening

and speaking; scientific thinking, defined as the knowledge of science, mathematics and the relationships between science, mathematics and technology; and technological literacy, including competence in the use of computers, networks and digital content" (CEO Forum, 2001). However valuable these broad definitions may be as guidelines for education, they are difficult if not impossible to operationalize for purposes of research.

Other definitions strive for a middle ground. Members of the library community, for example, faced with patrons who suddenly have access to vast, ill-organized databases and archives, define their goal as "information literacy," by which they mean, essentially, research skills — posing a question; identifying appropriate sources; finding, evaluating or synthesizing information; or using it in a product (ALA, 2001). This is what might be called a problem-based definition of information technology literacy: it reflects the fact that our digital environment has created new challenges — learners who can potentially learn from vastly greater access to resources, but who can also be sidetracked, slowed down, overwhelmed, or tempted to simply copy and paste information without thinking. Other, less useful problem-based approaches to defining literacy focus on the dangers youngsters purportedly face in using networked media, and on giving children the skills to navigate the web safely — not going to adult websites, giving personal information to marketers, talking only to people one knows, and so on.

Another interesting middle ground is the effort to define what have been called "generic" skills with information technology — conceptual and practical knowledge that cuts across tools and applications and reflects what is unique about the digital medium (Anderson et al., 1990). These include an understanding of connectivity (the movement of data across a network), logic, and digital representation of information. They also include use of common tools like a word processor, email, and a spreadsheet.

The definition of information technology literacy that comes closest to the one we set out to explore and further elaborate in this research is the hybrid description of "FITness," or "Fluency with Information Technology," created by the National Research Council (Committee on Information Technology Literacy, 1999). This report defines fluency in terms of three elements — skills with tools, computing concepts, and intellectual capabilities toward solving real-world problems using technology. Our definition is similarly hybrid.

We define digital literacy as a set of habits through which youngsters use information technologies for learning, work, and fun. Our definition strives for a middle ground between tool-based skills and the purposeful use of tools in actual settings. We examine youngsters' habits with information technology along the following dimensions:

- Their *troubleshooting* strategies
- The range of *purposes* connected to their computing
- Their skills in using *common tools* such as word processing, email, and web searching

- Their *communication* literacy — how they use email, Instant Messaging, and other tools to talk to peers and adults
- Their *web literacy* — how they use the web to find, cull, and judge information and their skill at creating web-based material themselves.

These dimensions of information technology literacy are described in more detail in the methods section below.

Research Question

Literacy, as historians and theorists of literacy remind us, is always multiple — *literacies* — and not singular; literacies are always situated in particular communities and particular practices; and literacies are always emergent, never static (Street, 2000). With this in mind, we pose in this study the following research question:

What kinds of digital literacy are emerging for children in low- and middle-income households where there is access to computers and the Internet, and why?

RESEARCH DESIGN AND METHODS

In September 2000, CFY and CCT began a one-year comparative study of children's home computer use in low- and middle-income families.

Institutional collaboration

CCT, a technology and education research and development organization, brings together three domains of work — research/evaluation, program design, and technology development. CCT has been conducting research on the roles technology can play in supporting learning and teaching in school settings for over twenty years. Over the past four years, CCT has been investigating the consequences of the digital divide for children's learning and development in informal settings including community-based organizations, afterschool programs, and homes. This work has allowed us to begin charting the influence of different social settings on the ways children embrace computer and Internet technologies.

CFY places free used computers with Internet access into the homes of disadvantaged children and their families. Since launching their program in 1999, they have provided home computers to about 1,000 families and teachers in New York City. CFY insists that all recipients attend a half-day training session on the CFY computer they then take home. CFY also insists that all students attend training with a parent or guardian. These prescriptions have led to CFY training more than 1,500 students, parents, and teachers since it began operations. Between 1999 and the end of the 2001–2002 academic year, CFY will have provided 1,500 families and teachers with home computers overall and will have trained 2,000 students, parents, and teachers. All these families and teachers will come from seven New York City middle school communities with which CFY maintains ongoing relationships (including providing teacher training).

From its inception, CFY and CCT approached the project as a collaborative effort. We worked together to establish criteria for selecting families and to develop research instruments. We established mechanisms for sharing data, including a visitation report structure and a schedule of biweekly review meetings. We created processes for working together to interpret and communicate our research findings.

Study Participants

Families were selected to participate in the study based on four core criteria. Families in both communities were demographically diverse, had children in the seventh or eighth grade, a range of educational achievement levels, and access to at least one Internet-connected computer in their home.

All the low-income families were selected from two CFY middle-school communities in New York City: one in Southchester and one in Eastside Heights. All middle-income families were selected from two middle school communities in suburban Greenville, New Jersey.[1]

The Low-Income Families and Their Children

CCT studied nine low-income children and their families. Eight of these families lived in Southchester and had children enrolled at CFY's first school partner: the Academy for Scholastic Excellence (ASE). One family lived in Eastside Heights and had a child enrolled at a school CFY partnered with the following year: the Power through Arts and Community (PAC) school. In this overview we describe these families in terms of their financial, educational, employment, racial, and lifestyle characteristics. We then describe the computing environment in the nine low-income households.

Income/education. The nine families in the study were all low-income and lived in a variety of housing conditions (e.g., public housing [2], rented apartments [5], and self-owned home [2]). They perceived and experienced their neighborhoods as unsafe for themselves and their children. Children were often discouraged or prohibited from playing outside. Similarly, adults and children may limit their social activities with neighbors or their use of community resources due to fears about safety. Of the nine mothers, five were either currently enrolled in college or had some college education, one had a high school degree, and three had completed six or fewer years of formal schooling. In the six families where there were fathers present, the fathers generally reported a comparable level of education. However, in one family, the father held an MBA degree.

Race/ethnicity. All families were of color. The majority were immigrants and did not speak English as the primary language in their homes. Three of the families were of Puerto Rican descent, two were Mexican-American, and two were from the Dominican Republic. Of the remaining families, one was African-American and one was African (Nigerian). In six of the nine families, Spanish was the primary language spoken between parents and children at home. In three of the families, English was the primary language spoken at home.

Family types. The nine families who took part in our study represent three different family structures and a total of sixteen parents. Six are two-parent families; two are single-parent families; and one is a divorced family in which custody of the children is shared between the mother and father. The number of children in each family ranges from two to four, with an average of three per family.

Employment. Both of the single-parent families are supported by welfare; one of these mothers also holds a WEP (Welfare Employment Program) job. In two of the seven two-parent (intact and divorced) families, both parents have jobs outside their homes. These families include two parents who are administrators, and one set of parents in which the mother is a paraprofessional and the father (who has an MBA) is employed in an undisclosed profession. In the remaining five families,

[1] The names of communities, schools, and individuals have been changed to protect participants' privacy.

the mothers do not work outside the home and the fathers have the following jobs: one is a manual worker at a food market; one is a telephone technician; one is a daycare worker; and two are businessmen.

The schools attended by the CFY children. Because the primary focus of this study was to examine children's computer use at home, logistic constraints did not permit us to alter our research design to collect data directly from the children's schools. CFY and the families themselves, however, were able to provide us with some information about ASE and PAC. (For information about these two schools, see Appendix 1.) Eight of the students in this study attended ASE, and one attended PAC.

Leisure and media use. The ASE students in the study spent little leisure time at home because their school day extended from 7:25 am to 5pm Monday through Thursday; 7:25am to 3pm on Fridays; and 9am to 1pm on Saturdays. Such hours are unusual for public schools. In comparison, the one PAC student in the study had a large amount of leisure time because, like most public schools, her school day extended only until 2:30 pm. Thus, the one PAC student had far more time to spend with media, including television and the computer/Internet than did students from ASE.

CFY children studied. Seven of the nine students were in seventh grade at the time of the study; two were in eighth grade. According to data gathered by CFY researchers from the students' teachers, three of the students were in the high academic track, five in the middle track, and one in the low track.

There are six girls and three boys in the CFY study sample. Two of these students have younger siblings, four have older siblings, and three children have both older and younger siblings.

Technology at home. All nine of the low-income families participating in this study received from CFY a Pentium-level computer with CD-ROM drive, floppy drive, and 56kb modem. The CFY computers were outfitted with the MS Windows 98 operating system; MS Office 2000; and CyberSitter 2000 (an Internet filtering program). For families that received their computers in the 1999–2000 academic year (in our study, eight ASE families from Southchester), CFY preprogrammed Internet Explorer with a set of 112 educational "bookmarks." These families received email accounts through CFY's email server or through *eChalk* (a provider of web-based email solutions to schools). For families that received their computers in the 2000–2001 academic year (in our study, only one PAC family from Eastside Heights), CFY built a tailored website, Community Corner (www.communitycorner.org), which was the homepage on all computers distributed that year. In addition, these families received email accounts through FirstClass, and additional software such as AOL Instant Messenger; Adobe Acrobat Reader, as well as ACCU-type (a free typing program).

Most of the CFY families purchased additional items for their computers. Some seemed to take great pride in purchasing computer desks—actual pieces of furniture designated for computer use. Parents also purchased hardware peripherals (e.g., keyboards, mice, printers, speakers, and scanners) and software (e.g., CD-ROM resources including encyclopedias, educational software, and games).

After receiving the CFY computer, one family invested in a very high-end computer system for the children that included a DVD player and fax machine. Another family used their scarce financial resources to buy a child's laptop (a functional model with printer) for their four-year-old daughter who wanted to use her older brothers' CFY computer but was prohibited from doing so. Interestingly, the mother in this family began to develop her own computer confidence and competence by using this toy laptop. She had not been comfortable using the CFY computer for fear she might break it.

Internet connectivity. In the 1999–2000 academic year (the year CFY worked with ASE), CFY provided families with unlimited Internet service from a local Internet Service Provider (ISP) at a reduced rate of $8.95 per month. CFY paid for the first three months of access, after which time, families were given the choice to either continue paying for the ISP themselves or to switch to another provider. In the 2000–2001 academic year (the year CFY worked with PAC), CFY provided families with a free, advertising-supported ISP that had not been available earlier. Most CFY families had only one phone line at home. When a family was connected to the Internet, they were unable to make or receive phone calls.

Formal computer training. CFY provided all children and their parents with three and a half hours of basic computer training. This training gives the mostly novice users familiarity with:

- Assembling computer hardware (and knowing what each component does)
- Using the Windows operating system (e.g., mousing, clicking, file management)
- Using MS Word (e.g., creating, formatting, and saving word processing documents)
- Connecting to the Internet using a modem
- Sending and receiving e-mail
- Browsing the web
- Configuring the Internet filter.

The Middle-Income Families and Their Children

We studied ten families from suburban Greenville, New Jersey, a small, racially and socio-economically mixed residential suburb located 20 miles west of New York City.

Income/education. The 10 Greenville families are comfortable by most American standards. First, they are comfortable physically: Greenville is a relatively safe community with little street crime, so that parents in these families allow children to walk around town by themselves or with friends at age 10 or 11. Second, the families are comfortable financially: all but one family own their homes, and most earn between $50,000 and $100,000 a year. Parents routinely pay for extra lessons, computer upgrades, and vacations that enrich their children's lives, even if for some these are a financial stretch. Third, these families have educational advantages: most parents have college degrees or higher, and all have at least some college. In addition, family size is small (most

have only two children), enabling parents to attend to children more closely than in larger families.

Employment. The 18 parents in these families work long hours at their jobs in order to support their middle-class lifestyles. Fifteen work full-time, in jobs that include clerical and service jobs such as records administrator and customer service representative and, on the higher-paying end, small businessman, partner in a PR firm, and lighting and sound designer. There are four full- and part-time school teachers in the group. Three of the women stayed home full time until recently to raise their children, and are now back in the work force. Two others work part time. Work involves significant commute time (over 1.5 hours) for at least one parent in over six of the families, usually the father. Reflecting the contemporary blurring of workplace and home, many of these families have home offices, which function either as a secondary work site (e.g., where parents work at night or on days when they stay home) or a primary work site (e.g., the place from which parents run a small business).

Race/ethnicity. The families in our study are racially diverse, reflecting Greenville's general racial mixture and tolerance. Six of ten are Caucasian, three are African American, and one family has parents of different races (by second marriage). Most families are American citizens born in this country; but one of the African-American families immigrated from Jamaica fourteen years before, and another family moved from England four years earlier.

Family types. Five of the ten families we studied were intact first marriages in which children lived with both parents. Two were single-parent families (one due to death, one to divorce); two more were second marriages in which the children lived with a stepparent; and in one family the parents were separating as the study occurred.

Leisure and media use. A consequence of parental work patterns in these families is that the children spend a large amount of unsupervised time at home, especially in the hours between 3:00 and 7:00pm. A large amount of this time at home, up to four or five hours a day, is spent with media, including television, videogames, and the computer/Internet. In short, home is where the media are.

The children studied. We studied six girls and four boys in these families. Five are in the highest academic track in their middle school, which means that they scored well on standardized tests and are bound for AP-level courses in the high school. Four are in the middle track, in which courses are not as intellectually demanding, though homework still can be heavy. None is in the lowest, or remedial, track. One parent is home-schooling her children. Most children have only one other sibling; four have an older sibling and six have younger siblings. Many, though not all, pursue hobbies and interests outside of school — music lessons, sports, drama, cheerleading, chorus; however, each student's intensity of involvement in these activities varies greatly and many have a good deal of leisure time, much of it unmonitored.

Technology at home. Two features of the computing environment in these households stand out: the great accessibility of networked computers and the continuous investments made in com-

puting. First, six of ten families have two or more working computers at home (two families have three, and two families have four). Nearly all families (nine of ten) have at least one powerful Pentium machine bought in the last three years. Families typically designate their most powerful networked machine the "family computer" and put it in a shared space such as living room, den, or guest room. Families with multiple computers typically regard the others as belonging to a parent (e.g., "dad's laptop," used for work), and/or as "the old computer," which they often put in a child's bedroom or basement, where it is used for games. For the most part, computers and the Internet are not recent arrivals in these households. Seven of ten families have had a computer for more than five years, and nine of ten have had Internet access for at least two years. Families pay an average of $30 dollars a month for Internet service, usually through America Online (AOL). One family has broadband network access through a cable modem. More than half the families have separate telephone lines for their Internet-connected computers, enabling family members to use the phone and the Internet at the same time. As a result, eight of ten of these families had fairly robust and stable computer and Internet access during the period of the study.

Parents in these families continually invest in technology, for their children as well as themselves: they shop for upgrades to new machines (three families had upgraded to powerful multimedia computers in the six months prior to the research, and one bought a new computer during the research); they buy laser printers or scanners or digital cameras they think will add value to what they already have; they browse software racks in stores looking for titles that might be good for learning or for fun or for practical tasks. They do not make these investments lightly, however, because for many they involve financial sacrifices.

Research Instruments

The CCT-CFY team developed interview instruments for both parents and children. The parents' interview focuses on information about family demographics, literacy practices, technology use and meaning, social networks, and social interaction. The children's interview and computer tour (e.g., show-and-tell exercise) were designed to map out a child's experiences with his/her computer and to identify his/her degree of engagement with these tools in the home setting.

Home visits

CCT researchers made a total of 49 home visits to these families (two or three visits per family) to observe computing practices and family environment, and to engage children and family members in interviews and computing activities. Home visits lasted approximately two hours and were conducted between the months of November 2000 and July 2001.

Data analysis

Researchers analyzed the family interview and observation data thematically (see Strauss & Corbin, 1990) around the following themes: family's housing conditions, immigration status, ethnicity/race, number of children; parents' profession, education, and experience with computers

and Internet; family's reading practices and TV-watching patterns, the location of the computer in the home; and the participating children's ages, academic track, and computer interest and use. These data were critical in forming the contextual backdrop to our interviews and observations of children.

For the child interviews and observations of computer use, we analyzed the data along the dimensions of digital literacy described below (see Table 1 for a summary):

Troubleshooting. Fluency on this dimension means being able to keep one's computer running when faced with inevitable technical challenges. The *closer* an individual is to being a technical problem-solver, the greater that individual's troubleshooting fluency. People with the highest level of troubleshooting fluency have the knowledge and confidence to solve technical problems themselves. People with a moderate level of troubleshooting fluency can find technical help from "close" family members, friends, or colleagues. Those who do not personally know anyone who can help them but who know how to call on more formal channels of support (e.g., phoning a help desk) exhibit the next lower level of troubleshooting fluency. Individuals with the lowest level of troubleshooting fluency are those who do not get their problem fixed: they know of no one who can help them nor do they make use of any formal channels of support, either because they do not know of any available to them or because they are afraid or uncomfortable to use them.

Given the large number of technical problems that people have using home computers (Keisler et al., 2000), these are skills and habits that are seriously underappreciated in the literature on information technology.

Purposes. This dimension of literacy refers to the social and personal ends that computing serves. Purposes can be school-related, communicative, recreational, practical/informational, or income-related. On this dimension, greater fluency means greater *variety* of purposes: a child who uses the computer to work on school projects *and* chat with friends *and* help a parent find a phone number *and* play games is more fluent than one who uses the computer for only one activity.

Literacy with common tools. This dimension of digital literacy means using and knowing what to expect from standard or common software tools. These tools include the computer operating system (for file management, e.g.), a word processor, email, a spreadsheet or database, and programs for displaying graphics and audio files. Greater fluency with these tools means both more *differentiated* use — familiarity with a range of tools — and more *depth* in using any single tool. We define "depth" as using more than the routine or surface-level features of a program to achieve *individualized* or *personalized* results or effects. In using a word processor, for example, a child who varies font style, color, and formatting to achieve an effect in a poem is demonstrating greater fluency than a child who never varies formatting or whose font or color changes are aimless. In this way, fluency with tools is connected with the concept of *authorship* — using technology to put one's own stamp on the world.

Communications literacy. This term refers to children's use of computer-mediated communication tools — email, instant messaging, chat, bulletin boards — for a range of purposes from recreation to work. Fluency in this dimension means being able to mobilize features of these tools for differentiated ends. The child who uses email or Instant Messaging only for recreational text-based chatting, for example, is less literate than the child who also uses the file attachment feature to send and receive text or audio files (e.g., lost homework or a song they want a friend to hear), or who copies URLs into messages to help a friend/relative access a recommended website, or who creates online chat profiles that include no identifying information, in order to protect his/her own privacy.

Web literacy. This dimension of literacy refers largely to children's level of ability to find and interpret information and represent their own viewpoint within the complex and chaotic information environment of the web. Greater fluency here means more effective research or "information literacy" skills — more effectively using search engines to find information; taking a greater evaluative stance toward information (e.g., the commercial nature of much web material); and using a web browser's features to more effectively organize ("store" and retrieve) web material or make use of web material (e.g., cut and paste web information, cite it correctly). It also means understanding the limitations of the web as a medium, for example, in comparison to other media such as books, and the library. Finally, it means establishing more of a "voice" within the web medium — creating a web page, contributing one's views or artwork to an existing site, etc.

Table 1. Digital Literacy Analysis Model

COMPONENTS OF LITERACY	CODES					
Purposes	**P1** School-related	**P2** Communication	**P3** Recreational	**P4** Informational	**P5** Income-related	
Troubleshooting	**T1** Self	**T2** Peer	**T3** Parents	**T4** Siblings	**T5** Neighbors Extended Family	**T6** Professionals
Tool literacy (Applications)	**A1** Word Processing	**A2** Image & Audio Tools	**A3** File Management	**A4** Search Tools	**A5** Communication	
Communication	**C1** Email	**C2** IM	**C3** Chat	**C4** Bulletin Boards		
Web Literacy	**W1** Search Strategies	**W2** Organizing Information	**W3** Evaluating Information	**W4** Authoring		

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FINDINGS

What levels and kinds of literacy are children in low- and middle-income households developing through their home computing? This section presents our findings for each group, starting with the low-income families and concluding with the middle-income families. It is important for us to emphasize in reporting our findings that the majority of low-income families in our sample were members of a unique school community, the ASE community (See Appendix 1). With its extended-day and mandatory weekend schedule, ASE substantially influenced the computing patterns and habits of these students. As such, it may be difficult to generalize findings from this low-income community to others.

Findings in all three sections are presented in the following order: We start with *troubleshooting* literacy, since this is a "threshold" issue — if technical problems are not surmounted, literacy levels in other categories will be greatly constrained. Next we discuss the differentiation of children's *purposes* for using their home computer. After this we discuss their literacy with *common tools*, their *communication literacy*, their *web literacy*.

Digital Literacy in Low-Income Homes

Troubleshooting literacy

For technical help, most of the low-income children (seven out of nine) relied mainly on their schools' computer/science teachers and CFY's help desk. As new computer users, they were unable to rely on themselves, siblings, parents, or neighbors for technical support.

While the CFY computers usually ran well, the major technical problem was around connectivity. Many ASE families found it awkward to transition from the three months of free Internet service provided by CFY to paying for access themselves. Because most low-income families have no credit cards, the participating ISP offered to accept money orders and checks from CFY families. Each month, the ISP would send an email bill to each ASE parent and child. Email billing frustrated and confused some ASE parents, especially those who were new computer users and were not checking their email regularly.

> Maria, an ASE mother: *"I just didn't know how to pay [the Internet bill]. I didn't know how to go about doing it. After three months, someone called and told me that I have to pay for the Internet. And I said, really? I didn't know."*

Most children and parents told us that they called the CFY help desk and asked for assistance with their computer and Internet issues. Families who needed computer repairs made use of two of the options offered by CFY. Some asked for a reference for a CFY-approved computer technician who then visited their home for a modest fee. Some brought their computer to their child's school where CFY repaired the computer. For ASE families, CFY was able to switch their Internet services to a free advertising-supported ISP once this option became available. If they couldn't find a con-

venient time for CFY staff to work with them, children usually asked their science and/or computer teachers for help.

> Maria: *"Our Internet was put back two months ago by CFY. [Their Internet had been disconnected because they missed two payments due to billing confusion.] We now have free access to the Internet, and don't have problems yet."*

> Maria's daughter, Valentina, 12: *"In recent weeks we used the services of CFY staff to fix the CFY computer Internet connection and received an upgrade of computer parts and training. CFY repaired our Internet connection; put in new sound cards; and got us free Internet access. [Valentina reported taking a bus and a subway to reach the place where CFY was making repairs.] CFY made it [the computer] better. We got more than what we were expecting."*

> Krumah, 12: *"I called the 1-800 number, the [CFY] help desk, because I deleted my Internet password, and also wanted some information about our billing problems."*

> Luis, 12: *"If I have questions about the computer, I ask Mr. Feldman [science teacher] at school. He helped me reinstall the software programs on the CFY computer."*

> Adriana, 13: *"I called the CFY number [help desk]. Two weeks later, someone from CFY came and fixed it. The computer is now working perfectly....If I have problems with the computer, I always can contact my computer and science teachers who always get back to me."*

A few CFY families (three out of nine) were better able to troubleshoot their technical problems on their own. In these three families, the fathers were able to provide home technical support to their children. Below is what two mothers have to say about their husbands' experience with and interest in computer technologies.

> Valentina's mother, Maria: *"The children's dad helps the children when there is a problem. He used to run a community technology program and my daughter borrowed CD-ROMs from his place. He is a proficient user of the computer and Internet at work."*

> Roberta's mom, Teresa: *" [My husband] is crazy about computers and electronics in general. [He] is always trying to solve technical problems with his own computer. For him the whole experience with computers is fascinating. He learned it in the Dominican Republic. He built his own computer with old computer parts. He is curious and keeps learning by questioning customers who have computer knowledge and who come to [his] bodega. He also buys books to learn about computers. For example, he got the Apple 1 Graphics because of his limited English. It is easier for him to follow graphic directions than text."*

In addition, older siblings were perceived as very knowledgeable about computers and thus were primary sources of technical support in the home. For example, one girl was helpful in dealing with any outside technical help.

Maya, 13: *"She [her older sister] knows more about the technical aspect of the computer and software. She is the program expert, knows more about the getting in and out of programs. She helps me a lot."*

Discussion

CFY's model assumes that most new users in low-income communities lack adequate networks of support for technical help. New users do not have the skills and confidence to solve technical problems themselves, and, in low-income communities, new users often have difficulty finding technical skills among the people with whom they have close ties (friends, family, or neighbors). The findings from our research support this assumption. The majority of the families and their social networks did not include people who had prior computer knowledge, and thus they relied on help from CFY and the school. This finding demonstrates that organizations like CFY are greatly needed to provide crucial technical support to new users in low-income communities, at least until they are able to build up some technical capacity themselves.

Many of the families in this study had difficulty maintaining their Internet connectivity, apparently due to financial factors, software conflicts, and possible misconceptions of Internet options. On the financial level, many low-income families do not have credit cards, whereas most Internet Service Providers (ISPs) require a credit card for monthly billing purposes. For the ASE families, CFY partnered with a local ISP that would accept payment through money orders or checks. Each month, this ISP would bill ASE families via email. This email billing led to frustration and confusion, especially among those ASE parents who did not check their email regularly. While one solution to the problem would have been to mail paper bills via the postal service, no ISPs currently bill this way — it is far more expensive than charging a credit card or emailing a bill.

The PAC family that used a free, advertising-supported ISP had far fewer connectivity problems. While this might suggest that free advertising-supported ISPs are the solution to connectivity for low-income families, unfortunately this business model has yet to be proven and many ISPs of this kind have gone out of business.

The installation of other ISP software sometimes conflicted with the Internet software pre-installed on the CFY computers. AOL, for example, marketed its software with offers of free minutes but still required families to input a means of payment (credit card or checking account number) at the close of installation. If a family fully installed AOL on a CFY machine, they could use AOL. But if they stopped the process (because they lacked a credit card or bank account or because they did not want to provide this information), the family was left with no Internet access at all: their CFY Internet software would be overwritten and AOL would not be configured to work either.

Despite warnings from CFY about this problem and despite the fact that CFY's local ISP was cheaper than AOL, many families tried to install AOL anyway. Some may have been intrigued by AOL's offer of hundreds of free trial minutes and some by AOL's services and branding. Finally, some

participants did not appear to understand that they could browse the web without AOL.

CFY solved software conflict problems of this nature by re-imaging the family's computer (bringing it back to its original state). This problem may have been preemptively addressed, however, through more comprehensive training by CFY, additional instruction in the school, or supplemental take-home materials provided to children and families. Alternatively, this problem could be solved if all ISPs were required to code their software to avoid catastrophic conflicts with competitive ISP software.

Our findings underscore that organizations like CFY are greatly needed to provide crucial technical support to low-income children and their families.

Low-income children's purposes for computing

The low-income children in this study mainly use their home computers for schoolwork. This is followed by communication and recreational purposes.

The centrality of schoolwork in low-income children's computing. Most of the children in the study (seven out of nine) use the home computer to complete and enhance their schoolwork. Their school-related activities include searching the web for answers to questions posed by their teachers, searching for information on CD-ROMs like Encarta, and typing their homework (for example, science experiments, book reports, essays on literature, language-arts writing contests, social studies projects, and math problems).

The following statements are participating children's comments about their schoolwork:

> Adriana, 13: *"I write my papers with the computer. I did a project on the Oregon Trail. We wrote, we had a poster board and we had a map. In social studies, I use it [the Internet] to answer questions like 'which person made this machine at this year?'"*

> Tisha, 12: *"Well, I usually use it [the computer] for homework. We had to do social studies book reports. If you type your book report on the computer, you get ten extra point on your grade. That's the reason I like to go on the computer. For instance, you get ganas, it's like extra credit, if you do something on the computer, you type it or something, that's what I really like about the computer."*

> Luis, 12: *"We also have every month, we have a contest, a writing contest. We have to do it in our class. And they want it typed, so we have to type it."*

Children's use of their home computers for school-related tasks was encouraged by the school and supported by all the parents (16). For example, ASE teachers reward students with extra points for typing their homework and finding online answers to teachers' questions. One of the mothers, commenting on the school's approach to getting the children to use the computer at home, said she supported it; she especially liked her daughter to use the spell checker and thesaurus in the computer while writing her school papers, to "add variety to the language she uses in her written work."

Tisha's mom, Michelle: *"[My daughter] uses the computer to type all of her science reports, which are so nice: the color catches you, the different captioning, the different headlines, the different decorations. She did all kinds of frames using the computer."*

Most parents (seven out of nine) monitor their children's use of the home computer. For example, most of the ASE parents make sure their children use the computer for schoolwork on weekdays and allow them to use it for computer games on weekend. These parents also monitor the time their children spend watching TV, and visiting with friends. All the ASE children in this study were middle or high academic achievers. In contrast, the one PAC parent (a single mother) and one ASE parent do not supervise their daughters much in their use of computer and other media.

One low-income student, Maya, uses her home computer for schoolwork less than the others; she used the computer at school to get her schoolwork done before she got home because she feels that her older sisters monopolize the home computer. Another student, Yolanda, indicated that she spends more time on communication and computer games than homework.

Recreational purposes. For the low-income children in the study, recreational use of the computer brought their families together and was fun. We observed stark differences between the one PAC student in the study (who had a large amount of leisure time during the week because her school day ended at 2:30 pm) and all the ASE students (who had very little leisure time during the week because their school day ended at 5 pm). In fact many ASE students could pursue recreational computing at home only on weekends.

For most children (seven out of nine), recreational time on the computer was family time in the safety of home. Family members spent time together typing their mother's college homework, writing letters to relatives and friends in other countries, writing to newspaper editors, scanning old family pictures, typing ancestral songs and religious verses (Rosario to the Guadalupe Virgin, Virgin Maria, Misterios), or scheduling church meetings and events. These families appear to have very strong sibling and parent-child ties, and computer activities help strengthen these ties. In this family context, many of their computing activities had cultural resonance.

Roberta's mom, Teresa: *"Before we had the computer in the home, we didn't get together much to do stuff. Today we use the computer together when I am typing my school [college] assignments, searching for things like scholarships on the Internet, playing games on the Internet, and scanning old family pictures."*

The most common recreational activity children cited was playing games. They played computer games (e.g., Solitaire, Minesweeper), games available on the Internet (e.g., chess, raising virtual pets), and games on CD-ROM (e.g., Barbie, Dr. Doolittle, Mathblaster). One student, Renee, authored a series of mystery stories on her computer. Others visited music sites and downloaded music files or pictures of musical celebrities they liked (e.g., Back Street Boys, Big Pun, Cuba); some typed letters and music scores.

Tisha, 12: *"When I go on the Internet, I usually look for like, lyrics for songs and I go on the*

teen thing in there. They have like, families, kids, then they have teens, and that's a gate you could click on, and then you can do different things like games and stuff. But I usually don't go on the Internet, really."

A final recreational activity the children cited was sending and receiving email and using Instant Messaging. These activities are discussed further in the section on communication literacy.

Discussion

The development of digital literacy in these low-income households is influenced by many factors besides the child's own excitement and interests: homework assignments; parents' belief in the importance of school work; families' strong sibling and parent-child ties; parents' rules and strategies for sharing the CFY computer among family members; families' culture and heritage; the degree of safety of the neighborhood in which the family lived; and the amount of leisure time most of these children had at home.

The schools these children attended helped increase their digital literacy by frequently assigning computer tasks for homework. Our data indicate that school assignments — which can be either perfunctory and list-like, or more synthetic and inquiry-based — may be important in encouraging students to use their home computers in substantive, diversified, and meaningful ways. In addition, most parents support and reinforce this pattern of use. They view access to school and computer technologies as crucial to their children's success in life.

Krumah's dad, Wole: *"It [the computer] increases the child's horizon. It makes them to see more than they're supposed to see and that is their education. It gives them the opportunity to know a lot of knowledge that wouldn't have been possible without the computer. It gives them the advantage of accessing knowledge."*

For many children recreational time on the computer is family time. This effect may be due, in part, to families' strong sibling and parent-child ties, which the computer helps to strengthen. Family time, however, is not always without conflict. Because CFY provides one family with one computer regardless of the number of school-aged children in the home, some children see the "CFY computer" as belonging to the oldest, middle-school-aged child. In some cases, younger siblings seem to veer away from using the computer because they did not consider the computer as belonging to them. In other cases, though, families develop elaborate scheduling and rule systems so that all children can have time on the computer.

Maya, 13: *"It's not my computer. It's... [my older sister's]. Because when we got the computer I was in sixth grade. My sister was in the same school and she was in seventh grade so she got the computer. It's... [my older sister's] computer but my mother says now it's all of our computer since it's at home and we all use it."*

Fieldnote: One family explained that they set up a schedule in which the three older children take shifts at the computer, so each has time to do his homework. The schedule is

coordinated so the children rotate the final time slot and the same person does not have to go to bed late every night.

When families come together around the computer, they often do so to pursue cultural-specific activities like getting news in Spanish, browsing the history of Meso-America, or finding and printing the verses of religious songs. In this family context, many of their computing activities had cultural resonance.

> Juan, 12: *"We explore the Internet together and show mother/dad about Yahoo. We'll search historical stuff about Mexico, ancestors (Maya, Aztec emperor). We found a free English tutor for Mom [who is learning to speak English]. Dad gets Spanish news at the website 'UNO Vision.' ... Some of the information about Mexican emperors we obtained from the Internet are posted on our living room walls, and the Mexican songs and religious items we typed are put in a binder."*

More than half of the parents (five out of nine) see their CFY computers as keeping their children home and off dangerous streets. In fact, for some parents, safety became a recurring theme in our discussions with them. In one interview, Tobias, Juan's dad, described his home as a haven surrounded by danger. Later in the study period, this man survived a stabbing that occurred in his neighborhood.

> Juan's dad, Tobias: *"The kids are going less to the library because they have the computer at home. It's not safe outside. I want them to stay in here and use it for school and play games together."*

The number of hours per day children spend at home with their CFY computer seems highly related to the school they attended. Given their extended school schedule at the ASE, eight out of nine of the children we studied had only a few hours a day at home with the computer, and very little leisure time. The one child in the study who attends PAC leaves school at 2:30 p.m. and has much more leisure time at home to work, play, and communicate on her computer. The amount of time children have to use their computer may directly affect their skill and confidence and thus affect their development of digital literacies.

Literacy with common tools

The low-income children in this study developed functional fluency with the various programs on their computer in the year since receiving their CFY computer. They showed researchers how they could use many of the applications such as Microsoft Word, their email program, Internet Explorer, and interactive games. Children also showed researchers how they managed files using their computer operating system and how they searched for information using a search engine. While these children are able to demonstrate these skills, they are not yet completely fluent with such tools as defined by the ability to make more differentiated and personalized use of the applications.

Below is a brief description of children's knowledge of digital tools — a knowledge they acquired

mainly from school, from CFY's three and a half hours of basic computer training, and on their own.

Valentina, 12: *"Basically what I do most is the word processor, the Internet and CD-ROMs."*

All of the children have some file management skills and can, for example, locate files they had stored on the hard drive, open them, and save them as new files. The relationship between documents and the application that created them seems less clear to many, except in the case of Word. Some, but not all, children also know how to change features of the desktop such as the background, and how to download and install files on the computer. They understand the difference between a file and a folder and the interface/relationship between the file management system in the hard drive and the visual representation of some files on their computer desktop. For example, most of them pointed out during the computer tour session that the file management system allows them to get more detailed information about the documents in the computer.

Maya, 13: *"We can see the documents and then we get everything more in detail. My dad and science teacher said don't mess with it."*

Valentina, 12: *"They told us in school that the hardware is basically like the computer's brain. Like the hardware is where it does everything. Where it has like all the information. Okay, then on the next icon is my documents and it has like all the documents that I've written. It has all these documents that I've written."*

Microsoft Word was the application the low-income children in this study use most often. With word-processing, they know how to use features like Help, save, zoom, cut and paste, open new file, format documents (e.g., font/size, bold/italic/underline, and page justification), insert picture, and spell check. The children use these functions every day in typing their homework assignments.

Adriana, 13: *"The first button that is right here, a blank page. That's to get a new page or a blank document. This is to open documents that you have saved. This is to save documents on disk. This is for printing back in the printer. That's to undo something that you have done. For example, I could do this and I have to type all of that, so I just go here and I hit it and it will undo it. That's Help. The heading I don't really use that. This is the font to change what you're typing — style. This is the size of which you're typing in. This is to make it bolder. Italic is to make it slanted. The U is to underline it. This is to make everything, no matter how the words are — like for example here all the words are not exactly squared, but then I highlight this which means I want to select that and then I go here and it's all in the center. Like it's centralized like a poem. Then I go here and it's like a perfect S square and I can go back here to make it — And that's basically all the buttons."*

Another application used by the children is ACCU-Type, a program that helps users learn how to type professionally. In addition, more than half of the children (six out of nine) knew how to play online interactive games (e.g., chess, sport). Some of the children (four out of nine) have

access to CD-ROMs, which their parents purchase and which are usually educational (e.g., Encarta, Math Blaster). These children knew how to use these CD-ROMs to search for information for their schoolwork; find fun artifacts (e.g., music, pictures); and manage these digital information files by downloading them or bookmarking them. Further, they are aware of the filter (CyberSitter 2000) installed in their computer.

> Valentina, 12: *"The filter means you can't get access to certain websites. I have Cybersitter. It's sitters, you know, like babysitter. It's sitters your cybering. Cybering's like when you're on the Internet. It is just something that blocks sex images and things that aren't supposed to, you know. It stops little kids from watching things they're not supposed to be watching."*

In addition, all of them know how to send and receive email and file attachments via the Internet. Most important, they knew when the best times are to connect and whether (or not) they are connected to the Internet.

> Juan, 12: *"My Internet is working. No, it's just that sometimes at a certain point of the day there's like a lot of people on the Internet and then all the lines are busy. Usually it happens on the weekends because people are not at work. Like on the week, usually like when I get home around 6–6:30 and I get on the Internet before 8:00 it's great till like 9:00. If I log onto the Internet like after 9:00 it starts getting busy."*

> Luis, 12: *"I know that I am connected to the Internet when those two little computer shapes right here [on the bottom right corner of the desktop] start to blink."*

Most of the children (six out of nine) in this study are more knowledgeable than any other family member when it comes to technology. This was true even though these children have not yet become completely fluent with most of these common applications. This knowledge may give them more opportunities to interact with family members and also may earn them greater decision-making powers in the family.

> Krumah's mom, Ize: *"He is good on the computer. He helps me. He is helpful in typing my homework."*

> Krumah, 12: *"My mom bought a new CD for my little brothers. I installed it on the computer. Like my Dad gave me a lot of work once to type. ... It's like they are depending on me more to help them. Like sometimes when I come home my brothers are waiting for me to fix something here."*

Discussion

The low-income children in the study have developed some fluency with the various programs on their computer in the year since receiving their CFY computer. Many are more knowledgeable than anyone else in their family.

Children develop fluency with various computer programs on their own, through CFY's training,

and through homework assignments. For example, at ASE, the science teacher took it upon himself to provide instruction on software such as Microsoft Word and on using the Internet. He also routinely assigned homework that required his students to do Internet research at home. Other teachers promoted the use of Microsoft Word by giving extra credit points to students if their research was typed.

While children developed some fluency in the year they received their CFY computer, they still have much to learn in order to make more differentiated and personalized use of these applications. We believe these children may become more fluent in a variety of ways. First, given more time, they may begin to use their computer in a more differentiated and personalized manner on their own. Second, children's knowledge of literacy tools may grow if they are required to use them in challenging ways in their schoolwork.

The role of the school and homework assignments in helping children gain fluency with common applications appears to be of greater importance for children whose parents do not possess these skills. Most of the parents in our study have limited knowledge of computers and the Internet because their jobs generally do not require regular use of computers. In fact, only five of the sixteen parents in the study indicated that they use computers regularly. As with print literacy, when parents do not have the skills to impart to their children, the children lose the reinforcement at home and it becomes even more imperative that the school redouble its efforts. CFY's teacher development program has an important role to play in helping teachers integrate the common software applications (such as the word processor, email program, spreadsheet application, and presentation software) into school assignment in relevant ways.

Communication literacy

The CFY children's online communication literacy skills consist mainly of emailing peers and friends, and few of them (2 out of 9) were starting to engage in IM and chat activities by the end of this study.

The use of online communications is entirely the child's domain in the household. All children are familiar with email and often learned to use it from CFY training and the school.

> Tisha, 12: *"Sometimes like the teachers, like they want us to know how to use the email and everything. They taught us that everybody has to send email to one of their teachers. And then sometimes I email my friends. Like if I find a nice picture on the Internet, then I'm going to email it to them."*

Two of the children use email for school-related activities. One child, who does not have a printer at home, sends herself completed homework assignments at school so she can get them printed. The other child uses email to send in her homework and ask questions of her teachers.

> Valentina, 12: *"I send an email to myself with an attachment that's my homework. So when I get to school, I just open my email and I print it out."*

The children primarily use email for socializing with peers, especially classmates. For example, one child, Yolanda, enjoys chatting online with peers using Instant Messaging. Even at school she said that she often talks to her friends about when they will be on chat rooms, and added that she could recognize who else is online by their screen names. She also had a Yahoo account and screen name, which she created herself. Some children also enjoy emailing or chatting with strangers, although communicating with strangers holds less appeal for these children than communicating with their classmates.

> Yolanda, 14: *"I am bored and I want to chat with them [friends or strangers]. I call them at Yahoo chat. In FirstClass, chat area is in school, I send and receive messages. We talk about [on and off-line]: where we're going tomorrow, what we gonna do in class (English, computer, science), lunchroom talk to friends about when they will be on chat."*

> Valentina, 12: *"Usually I start with, 'Hi, my name is' — I use my screen name. And then we talk about like what's your favorite food. Where do you come from? Where do you live? Do you like your neighborhood and stuff like that. I love chatting on it because you get to know other people. You could chat with people who live all the way across the world like in Asia."*

Discussion

Simply by virtue of their participation in CFY's program, children in our low-income sample had instant access to an online community of classmates and teachers. (CFY provides every student and teacher with a home computer, Internet access, and an email account.) Within this wired environment we found that many factors influenced the development of communication literacy skills among the low-income children in this study. Among these factors were: the period of time that students had their computers; the amount of leisure time most of these children had at home, their ability to maintain reliable Internet connectivity; the attitudes of these children's parents toward communicating over the Internet; and the assignments children received from school.

Many of the low-income children in the study us their computer to communicate with others. They primarily communicate with friends and primarily use email. While CFY teaches children how to email during their training session, children learned about chat and IMing on their own and are just *beginning* to use these functions (two out of nine have used them). These tools are relatively new for them and their friends, and many have not yet created screen names or buddy lists on Instant Messenger. Two children did say they have gone to chat sites, including talkcity.com and chat.yahoo.com. One child explains it this way: "So in communicating, like I'd probably — If I had found out about the chatting sooner, I would have been chatting more."

In examining the amount of time students spend communicating on their computers, we observed stark differences between the ASE students (who have little leisure time for sending and receiving email) and the one PAC student (who has a large amount of leisure time to send and receive email). Overall, few of the ASE children use their computers regularly for communication. The one PAC student, Yolanda, in contrast, said that she has more than 100 friends.

Yolanda, 14: *"Half of them [my friends] live across the street, down the block, off the block, in the building [in the housing projects], and are from school."*

Although Yolanda is a low academic achiever, she said that she likes school. "It's fun because of the teachers are cool, and gym." As stated above, Yolanda enjoys using FirstClass to communicate with friends and teachers.

Another factor that affects how much time children spend using their computer to communicate is the family's ability to maintain Internet connectivity. As described in the section on troubleshooting literacy, many families in this study had difficulty maintaining a reliable connection to the Internet due to both financial factors and software conflicts. The ASE families in this study (who started off with an unlimited paid Internet service provider) had more difficulty maintaining reliable connectivity than did the one PAC family (who started off with a free, advertising-supported Internet service provider).

Parents also play a role in the amount of time their children spend using their computers to communicate. Some parents are dubious about their children communicating over the Internet, especially with strangers. They instruct their children not to provide personal information (e.g., name, address, home telephone, and social security number) about themselves or other family members over the Internet. Some parents (four out of nine) do their best to monitor their children's use of the computer. For example, one mother positions the computer in the corner of the family's kitchen table, so she can supervise her daughter's computer use.

Tisha's mom, Teresa: *"And this one [computer] we keep here [kitchen table], partially because they share a room, and partially because I can see whomever is doing whatever. I like it here, because I can see what's going on. I know when they're online, I know when they're doing homework, or whatever it is that they're doing."*

The exchange below also illustrates parents' feelings about online communications, especially when it is a girl engaging in it.

Valentina, 12: *"So I usually go to a chat room and I see some downloads so I just like type in the name and IM back and then I press enter and I send them a message. And you pull up who you want to talk to."*
Valentina's mom, Maria: *"So that is pretty crazy."*
Researcher to Valentina: *"Do you like it?"*
Valentina: *"I just started doing it. It's fun. We gossip about like music, boy groups, people."*
Maria: *"Boy groups?"*
Valentina: *"Like I say like music boy groups. Like, you know, BackStreet Boys, *NSync, 90 degrees."*

It appears that the low-income children in this study will, over time, develop greater and greater communication literacy. As more children begin to explore Instant Messaging, they will likely convince their peers to do the same. In addition, children will be better able to use their computer for communications as families become better at maintaining reliable Internet connectivity and as

parents and their children develop a system of supervision and oversight that is comfortable for all. Finally, schools play a role in developing children's communication literacy as teachers assign homework that uses email, email attachments, or other forms of communication.

Web literacy

Most children (eight out of nine) developed some Web search and file management skills such as strategies for accessing information in the Web, as well as ways of organizing the information that they find.

Most children learn about websites to visit from school, CFY, and TV. At school, teachers often recommend educational websites to visit. For ASE students, CFY loaded 112 educational bookmarks on each computer. By the time CFY began working with PAC, CFY had developed its tailored web portal, Community Corner (www.communitycorner.org), and had made this site the home page on each computer. TV was another source of website URLs for these children.

Children's most common search strategies are entering specific website URLs (e.g., www.encyclopedia.com) and going to specific search engine sites (e.g., Yahoo, MSN). Once they find the information they were looking for, half of them use bookmarks to organize and keep track of the information. Another way they manage digital information and artifacts (e.g., pictures, music, and text) that they find on the web is by downloading and organizing them on their computer hard drive.

The children go to the web to look for information they can use in school assignments. They said that they like websites with a lot of visuals, links, and updates. At ASE, for example, the students were asked to go online and do research on current information, and general questions such as "What is the largest ocean in the world? What is the largest seashell in the world?"

> Tisha, 12: *"Today we've been studying slavery, so we had to go on the Internet to look up these websites about stuff that we can't get [from textbooks]. Say we're studying modern-day slavery, so that's not in textbooks, so we have to look on the Internet and research different stuff like that."*

> Valentina, 12: *"It was a writing contest for school. We had to find out the average family income in the Bronx. I went to Ask.com and asked the question, What is the average family income. I go to this website pretty often, like a couple times a week sometimes."*

Half the children use the web to look for practical information needed by their families such as housing, car sale, etc. They also go to the web for entertainment.

> Valentina, 12: *"ABC.com, the reason I have that down as my favorite is because I like to play while they have the thing on the TV, the 'Who Wants to Be a Millionaire' while people on TV are playing it.*

Discussion

Though the children have not exhausted the web search and file management opportunities available to them, they are starting to venture into new web territories, especially in their awareness of the credibility of the sources of information and their increased preferences for youth topics and perspectives (three out of nine). Web literacy is definitely an area that these children can be given literacy support, especially information management, awareness of the source and credibility of information sources, and authorship.

Digital literacy in middle-income homes

Troubleshooting literacy

Seven out of ten middle-income children report that they troubleshoot technical problems themselves; all ten middle-income children say they get help from knowledgeable family members, friends, and relatives.

When these children troubleshoot problems themselves, they do so mostly by trial-and-error and, more rarely, by consulting manuals or on-screen help. The types of troubleshooting they described doing include: getting peripherals to work when setting up a new computer (using an on-screen manual), overcoming persistent crashes (by reinstalling a program), recognizing server failures (by interpreting error messages), and finding misplaced files (by searching the computer hard drive).

> Lucy,12: *"My brother and I set up the computer all by ourselves, and when we didn't know how to do something, we went to the HP Tourguide to figure it out."*

> Fieldnote: When Cole, 13, keeps getting "server not found" messages for a chat page he likes (Damaged.net/pwchat), he first retypes the URL twice, then says: "Let me try a different address — htloz.com. It's another way into the damaged.net server."

The children's troubleshooting strategies do not always work, but they show confidence and resourcefulness:

> Fieldnote: Mike, 12, says that when he got error messages in trying to play a sound file he had downloaded, he typed them into the search box in the ask.com website.

Not all children show this level of personal confidence. Two children, both girls, saw themselves as the cause when something went wrong. One said: "I don't want to [download anything]. I did that before, and I broke the computer." But four of the girls showed confidence in troubleshooting problems themselves.

All ten middle-income children showed a propensity to seek and get help from others — first and foremost, from those closest at hand in the house — when they were not able to fix a problem themselves. Six children turned for help to parents, and three turned to older siblings. (When older siblings were in the household, they were usually deemed the computer expert.) Two children described getting help from extended family members such as uncles or cousins.

Three children turned to peers for help, usually school friends, especially around the use of Instant Messenger, such as managing Buddy Lists. Two sought help online, from the Microsoft and ask.com websites.

Children in this middle-class suburb do not themselves make use of telephone help lines, though some parents (eight out of eighteen) occasionally do so.

Parents in six of the middle-income families provide troubleshooting help to children. Their ability to do so, and also to get help from others, comes in part from their own substantial experience with technology in their work lives, and in their family backgrounds.

> Ben, 13: *"If I can't figure it out I ask my dad for help. He does a lot of stuff with computers in his job."*

> Margaret, Renee's mom: *"I feel confident in solving pretty much any software problems — like when AOL numbers don't work for access. If I'm stuck I can use onscreen help, or read manuals, or ask Dad, or a friend. ... My grandfather was a physicist at Bell Labs, and he's a photo and computer expert — I think my confidence comes from him."*

Parents in seven of these families also draw on the technical knowledge of relatives such as uncles and brothers-in-law and even grandmothers, whom they contact by phone, or ask to look at the computer during family visits.

> Patrice, Phoebe's mother: *"Right now our computer is so full, it crashes a lot. Something about the memory. I'm going to phone my brother-in-law in Florida — he'll walk me through it step by step."*

> Margaret, Renee's mom: *"We have a cousin who's a computer whiz — we call him up and he tells us what to do about hardware problems."*

One mother named Vicki, when she was divorced for a time and had no closer recourse, took her computer into the law office where she works, and had the computer department fix it for her, free of charge. This underscores the role of middle-class workplaces in creating a foundation for families' and children's technological literacy.

In two families, when a computer broke it was left un-repaired, because these families, like more than half of the Greenville families, had other computers they could use.

Discussion

Children's troubleshooting literacy in these households appears to rest on two things. First, children exhibit considerable *confidence* that technical problems can be solved. Even when their problem-solving strategies do not work at first, these children often persist in believing that they or someone close by can fix the problem, and this persistence often leads to success. Such confidence appears to be a learned behavior, born of expectations and experiences of efficacy and success that reside in the family as a whole. Sometimes, parents may deem their children's sense of

efficacy more important than the computer hardware itself. For example, Cole and Mike, two boys being home-schooled, described how their experiments with the computer often led to crashes, and Carol their mother said: "But I don't mind that, because through the process [of experimenting] they're expanding what they know."

The second major factor in these middle-income children's troubleshooting was the amount and quality of technology expertise that resides close at hand — among parents, older siblings, and extended family members. The adage that successful use of a personal computer depends on "how close you are to a nerd" seems to hold true for these families, who are all only one or two steps removed from someone they characterize as "a computer expert," and who regularly helps them navigate the software and hardware snags that arise persistently for everyone. The availability of such knowledge and expertise in their immediate family and social networks is rooted in social-class factors of employment and education; parents and extended family members encounter computers and computer troubleshooting in their work lives, in their schooling, and often in their hobbies. Even when they do not have such experience, high levels of literacy and experiences of efficacy make them relatively comfortable reading manuals, and asking others for help using whatever language they have available. These activities, in turn, model troubleshooting habits and attitudes for their children.

Middle-income children's purposes for computing

The middle-income children in this study mainly use their home computer for communicating with peers, mostly using Instant Messaging. This is followed by recreational purposes (such as playing games, browsing websites, and downloading files), and then by school-related purposes (such as typing reports and doing web research). A subset of children (three) also pursue in-depth, creative projects with the computer (such as writing music and publishing webpages).

School-related computing is a given for these children — all of them do it regularly, (though in very different amounts). But schoolwork competes with communication and recreational computing for their time and attention, and is usually eclipsed by them. Practical/informational purposes are not central for this group, nor are income-related uses.

Communication. Seven out of ten children use the computer for communication more than, or as much as, they pursue other purposes. Four children could be called "high" communicators — they say they go online every day to talk to friends using Instant Messenger, and they have between 50 and 120 buddies on their Instant Message buddy list.

> Lucy, 12: *"I like IMing best. On AOL. Talking to friends. I run home after school so I can beat my brother to go on. All my friends have it, practically, so when they're on, I can talk to a bunch at the same time. I like using AOL better than the phone, and that's why."*

Three children could be called "medium-to-high" communicators — they say they go online three or four times a week to talk or check email, and they have between 20 and 50 buddies. The three remaining children could be called "low" communicators — they say they go online to check email

once a week or less, and they have between 0 and 20 Instant Message buddies.

Greenville children "talk" mostly to people they know and see regularly — peers from school, other local kids they have met through these friends, friends from summer camp, and more rarely, relatives. They frequently exchange AOL screen names with new peers they meet (the fact that so many peers' households are online with AOL means that a ready-made social milieu exists online for them). Three of ten children say they regularly talk in chat rooms to people they do not know. Greenville children prefer using synchronous communication (Instant Messaging or chat rooms) to using asynchronous communication like email. Messaging for them is recreational rather than instrumental — they do not go online to talk to specific friends so much as "to see who's on, and to talk."

Recreational computing. Eight out of ten of these children say that for them, using the computer is "mostly about fun" rather than "mostly about work." Their most common recreational pursuits (excluding communication) are playing games, browsing the web, and downloading music files and pictures. A subset of three children use the computer for sustained, in-depth pursuit of hobbies or interests.

Games played include CD-ROM-based games like X-Men and the Sims, educational or "edutainment" titles like Math Blaster or Carmen Sandiego, and common computer-based games like Solitaire and Free Cell. Five children said they played games on the web regularly, including Neo-Pets (an adopt-a-pet game), doll dress-up games, online chess, and networked battle games where they compete with remote players.

> Phoebe, 13: *"Mostly I like playing games, like Sonic Adventure. Or Spiderman, or Arcade. We also have learning games on CD-ROM. Like Treasure Math Storm. I used some of the CD-ROMs in school and then I asked my mom, and she got some for me."*

Browsing the web was a popular recreational activity for six of the ten children. The websites they visit are most often related to commercial entertainment and products such as MTV, Gap clothing, bands they like, and movie and TV celebrities. At least three children who went to these sites had printed out photographs of favorite pop artists, and two girls had put them up in their bedrooms. Some band sites have audio clips of music that children play, and some movie sites have movie clips; four children have powerful enough computers, and the right software, to play multimedia clips like these. Children share these sites with one another readily.

> Craig, 12: *"I go to freearcade.com to play games, and I like going to sites for the bands I like, like korn.com, blink182.com, and eminem.com."*

> Eliza, 12: *"Someone will say, oh you've got to check out this site I found — the perfectjoke.com, or the internet movie database. We don't really talk about the computer - we just talk about what we saw on it."*

Finding and downloading music files is a popular activity for four of the ten children. (Napster was a very popular file-sharing utility during this research.)

Lucy, 12, showing her 60 or so music files: "[The Napster] Library is my favorite — it's where all my songs are stored. They're alphabetical - most of my songs start with I for Insync [sic]." She pulls up a track and plays it and the music comes pulsing out of the multimedia speakers. "This is their latest song. It's from their new CD, that's not out yet."

Finally, three out of ten children have created their own homepage using AOL templates (which make the process very easy). The pages consisted of basic personal information, like favorite music and websites, and in one case, original poetry.

Creative recreational computing. Three children stand out in their recreational computing because they engage in in-depth, creative projects using the computer. Cole, who is being home-schooled, maintains his own web pages devoted to the electronic games he loves, hoping they will attract the sponsorship of the gaming companies. He regularly emails the hosts of similar sites, and contributes game reviews to their sites. All told, his own site has registered 1,123 hits during the time of the research — something Cole is proud of.

Cole, 13: *"This is the gaming site....[types in www.geocities.com/ gamingzone2002] I wrote all the reviews. Here's my review for Guilty Gear X. This is the best one I ever wrote, because I wrote in paragraphs. And I had the set-up [layout] nice, with the pictures, and the text all put together."*

Eliza, a girl who is very involved with music, composes songs using a music-writing program her mother gave her as a present, types her poems and lyrics using MS Word, and visits websites devoted to songwriting and song lyrics in order to get ideas.

Eliza, 12: *"Sometimes if I like a song we're doing in chorus or something I'll borrow the sheet music from the teacher and then copy it into this [Midisoft Desktop Music 2000]. It takes about an hour, but it's worth it. Cause I can play the parts back, one part at a time. So for the tricky rhythms I can see what the left hand's doing, what the right hand's doing on the piano."*

Ben and his best friend were bored every day after school playing video games until they found several websites devoted to *BattleBots*, their favorite television show, and began building their own robot to enter into competition. Guided by information posted on the websites, they created an initial robot design, then revised it as they built the robot piece by piece in Ben's basement. They used a spreadsheet to keep a budget for the money raised from neighbors and parents' co-workers, used a computer-aided-design program to make more elaborate 3-D drawings of their robot, and queried design experts on the websites when they needed help with a mechanical or design problem.

Ben, 13: *"Building the robot has been going great. We found this program called Rhino 3-D, it's a 3-D design program and it let us design the body in 3D. To buy the CD-ROM costs 739 bucks, so we downloaded it on the web. It's better than Auto-CAD for us; with auto-CAD you can only design stuff in two dimensions — width and height. In Rhino, you can see the*

design from four different points of view. We saved the file, the different views, and we printed them out. It's helped us see what the bot's going to look like, and how to make changes."

School-related computing. All Greenville children say they use the computer for school-related tasks at least once every two weeks. For all the children, school-related uses move to the forefront at times when reports or major assignments are due. But the children differ in the degree to which school tasks are central in their overall computer use.

For five out of ten children school-related tasks take a back seat to communication and recreation. Their school-related computing is limited to two common tasks — typing reports and homework assignments, and occasionally looking for information on the web. They fit their homework in around their recreational computing, rather than the other way around.

Darla, 12: *"I usually type my homework in the morning before school, when my friends aren't IMing. I don't want to miss anything."*

Three of the ten children say that their school-related computing follows close behind, or is about equal to, their chatting and recreational computing. These three children are in the high academic track, but also spend a great deal of time in online recreation. They appear to balance school and non-school computing fairly successfully, aided by their parents, who set limits on their chatting and game play, get involved in finding good software and websites for their school projects, and teach them how to manage their time and the multiple demands on them.

Cole is an example of a child who balances school-related and recreational computing. He is being home-schooled by his mother and has a lot of studying to do at home, but he is also very involved with the computer: playing computer games, taking a course in Japanese on the computer, learning about programming, and studying topics and questions his mother assigns using websites she identifies.

Carla, Cole's mom: *"We've visited the whole world. There's so much information. We can hear French radio to reinforce our French. There are books online. We can read the Constitution, or the Declaration of Independence. We study the Amendments and look right at them."*

Two of the ten children say that school-related tasks are a *focus* of their computing activity, well surpassing their recreational computing. Renee, a girl who is in the high academic track, says, "The computer is mostly about work for me. I have so much work!" Her work consists not only of typing and web research, but also web-based simulations and web quests(inquiry exercises) that her teachers assign, and more elaborate science projects involving graphs and spreadsheets, for example.

Three of the more school-focused children showed the researchers technology-related schoolwork that was more in-depth than a report written with information from the web. One girl had done a stock-watch simulation for her social studies class, requiring her to pick a stock and follow its value all year using websites and the newspaper, then write a report summarizing the stock's performance at the end of the year.

Eliza, 12, in an email: *"Mrs. Wiggins, my math teacher, assigned [the stock activity] towards the beginning of the year. Our goal was to pick two stocks that we thought would earn us money. We recorded the stock's information about once every month, or went back to a month using the historical quote function on the website. Our goal was to gather enough information to write our paper, and draw a graph. Stocks are a great way to study math; we had to figure means, medians, and modes, all of which we were reviewing that year. I know that stocks could be a major part of my life later, and it was helpful to learn about how they work and make us money."*

Another girl showed researchers a science fair presentation on "killer backpacks" in which she used Excel and a graphics program to summarize data about a survey of backpack weights and back pain experienced by fellow students. Both these children are in the high academic track, where they are given more ambitious assignments than other children in the school.

Cole, the boy being home-schooled, showed the researchers an assignment asking which events led to American involvement in the Vietnam War, for which he used the web to find out about French Indo-China, and the anti-Communist fervor that followed World War II.

Discussion

Three issues loom large in the patterns of home computing we observed with the middle-income children: the large amount of leisure time these children have, parents' rules and habits in monitoring children's media use and their homework, and the nature of the assignments children get from their school. How children balance the different kinds of home computing — school-related, communicative, recreational — reflects these three factors.

Children in this group tend to be home after school between the hours of 3 and 6pm, often alone or with a friend. Unlike children who are in school or afterschool programs until evening, they have a significant amount of leisure time that they must decide how to use: for homework, for socializing on the computer and telephone, for watching television, for reading or creative projects, or for playing videogames or computer games. The computer is unique in that it is a medium for both work and for recreation/socializing. A common theme in children's talk is their struggle to negotiate work and fun when they come together in a single medium. For some children the boundary is fluid. One boy said that he cannot concentrate on his homework unless he is online with Instant Messenger open, able to switch back and forth between typing his homework and chatting — his mind just becomes "too restless" otherwise. Others work to maintain the boundary between work and fun. One girl said she goes online to do homework using her mother's screen name — not her own — because "I'm not like other kids — I really need to concentrate to do homework, and I get distracted too easily if people are private messaging me. Also, I think it's rude not to respond to them."

Parents' habits in monitoring children's schoolwork and media use also influence children's computing. All the middle-income parents interviewed want their children to do well in school and

believed their home computer could aid children's school success, but parents do not act on these beliefs to the same extent. In the five families where children were more focused on school-related computing and creative hobbies, parents do many of the following: they create and enforce rules putting homework before television, videogames, and Instant Messaging; they place the computer in locations where they can monitor it more easily; they use AOL's parental controls to limit the sites, and the number of hours, that children can be online; they help children use the computer for schoolwork, and they talk to their children about what they think is good, and bad, about the web. In the five families where children were focused mainly on recreational computing and less on school computing and creative projects, parents put fewer limitations on children's commercial use (three allow computers and televisions to be in private spaces like the child's bedroom), they do not use parental controls to limit net access, and they do not talk to children about their misgivings about the web. This said, *all* parents expressed at least some confusion or frustration at their relative *inability* to monitor and control precisely what their child does on the computer, the sites they go to, the people they are talking to, what they are talking about, etc.

Finally, the school classes children take also help determine the kind of computing they do at home. The six children in high-track classes are more focused on school-related tasks than the four who are in middle-track classes. This may be due to their greater academic achievement orientation; however, it also appears that children in the high track classes are also given more ambitious assignments that ask them to use technology in more interesting ways. High-track children (and the home-schooled student) are more likely to use the computer for long-term projects, as opposed to short reports, and to use the web as a source of information for thinking or problem solving (as in the stock simulation) and less as a repository of facts to be copied down. Some high-track teachers assign web quests and two even have their own web pages where they post assignments, resources, and class notes.

Literacy with common tools

All the Greenville children studied have at least basic or functional literacy with word processing and file management. Just over half (six) are becoming fluent with a new generation of graphics and audio tools. Four have achieved fluency in using the advanced features of several tools to enhance their self-expression and creative abilities.

Word processing and spreadsheets. All ten children showed facility with word processing software, which they use regularly for school tasks, and sometimes for their own personal and recreational uses. Over half of the children (six of ten) appear to have functional literacy with word-processing features — for example, they know how to use basic text formatting features like changing font style, size, and color, and they know how to cut and paste text from other sources (such as web pages) into text documents. Lucy, for example, likes to print out her work in a pink font. But like other children with basic facility, she does not use font changes to any particular effect:

Lucy, 12: *"I like using fonts like Century Gothic, Comic Sans, Jokerman, Juice. Because they're fun. I don't use them with my English teacher, though - he's proper. He would tell me, 'Just use a font that I can read.'"*

Four of ten children are *fluent* with word-processing features — for example they used the margin feature to vary the line shape of a poem they had written, they incorporated images and Excel charts into a report, and they used the "track changes" feature to keep track of edits in a co-written document.

One child has difficulty typing and felt this slowed her down a lot compared to her peers. For the rest, typing is not perceived as a difficulty. It is a skill they have acquired through email and Instant Message communications (4), through classes they had taken in school (3), and also by working with learn-to-type programs their parents had bought for them (2). Five of the children are very fast, fluent typists.

Two of the children have used Excel spreadsheets — one in creating graphs for a science fair presentation, the other in maintaining a budget for a personal project he and a friend were doing. Both learned the program with the aid of a parent.

Graphics and audio tools. Six of ten children have acquired basic literacy with new consumer-level tools for capturing and manipulating images and audio files.

Five children have created digital pictures using a digital camera or scanner, and manipulated them using graphic software like Photoshop and Barbie Photo Designer. Three children helped parents or siblings put family photographs onto their computer as screensavers and as a way to share them with relatives, via email. Two children used graphics software to open and resize celebrity photos they had gotten from the web, before putting them on their bedroom walls. One girl recorded audio messages with her brother and sent them to friends during IM sessions. Four used simple graphics software like Greetings Workshop, Windows Paint, and Disney Art Studio to create birthday and holiday cards and send them to friends and relatives.

Five children also use the web-based audio tool Napster to find and download songs they like from the web. Children were taught to use Napster by older siblings, friends, and sometimes by parents or other relatives. In two families children download songs as part of family gatherings, in others they do so privately or with friends. One child used a CD burner and Adaptec software to create mix CDs for two friends.

Most children use these consumer-level image and audio tools for informal family communications and entertainment. Three, however, created more polished presentations using the features of these tools. One boy helped his father create and run a PowerPoint slideshow for a Manhattan event that the father (an audiovisual producer) was working on. Two others created PowerPoint presentations for their social studies class that were organized nonlinearly and used graphic and audio elements to deliberate effect.

> Eliza, 12: *"Usually when kids do PowerPoint they just have a slideshow playing. You just press buttons, you don't get to perform what you know. But I like to speak. I like drama too. So we did [a presentation] where we stood at the front of the class, and played music with each slide, and then spoke over it."*

File management. All ten Greenville children show a functional grasp of their computer's operating system and the basics of file management. For example, they can navigate to and open applications and files in multiple ways (using the Windows Start menu, or the Apple Finder, or starting from either a file or an application), and can save and retrieve files from multiple storage media (floppies, hard drive, email).

Three children show greater fluency in the ways they manage files, by storing and sorting them according to a personalized organization scheme. For example, Eliza, 12, sorts her files into separate categories with labels like "Projects – Typing," "Songs," and "Personal Writing." Every six months Renee, 13, culls from her desktop folder the files she is very interested and invested in, and saves them on a floppy disk. She now has six floppies filled, with labels like "Renee – academic' or "Renee – poems". These children are thus learning to organize and store the often ephemeral-seeming world of computer data in terms that correspond with their own selves and interests.

Discussion

Beyond the basic skills in word processing and file management that they all share, two broad trends can be discerned in the tool literacies that Greenville children are developing. About half the children are becoming fluent with the current generation of "consumer" technology applications — tools for downloading and playing music, graphics and game files, for taking digital pictures and sending them to relatives, for customizing simple templates for greeting cards or homepages. These tools provide some latitude for creative expression and personalization, but not much — generally they offer users limited choices among pre-formatted options, such as filling in greeting card blanks. Meanwhile, another half of the children (about four) are learning to use software tools and games in ways that enhance their self-expression as well as their intellectual and creative ability. These children are using more advanced features or versions of each of the tools we observed — word processing, graphics and audio tools, and file management — to further their interests and abilities in complex activities. Personal interest clearly plays a role in the development of these two sets of literacies; but family and school factors also appear to play roles, as discussed below.

Communications literacy

Seven out of ten Greenville children use communication tools every day or nearly every day. Instant Messenger (IM) is the "killer app" for these kids, followed by email, and then chat rooms and bulletin boards.

Instant Messaging. The seven Greenville IM users like to talk with as many of their friends as possible at the same time; their major literacy challenge in using IM is coordinating simultaneous conversation with multiple partners in a text-only medium so that misunderstandings and hurt feelings are minimized. Eliza characterizes it well.

> Eliza, 12: *"It's like having sixteen different phone lines that you can talk on all at the same time, if you have sixteen friends on.... Mom thinks it's so confusing, like 'how can you talk to all these people at once?' It's like, well you just, put up their screens, they have their separate screens. It's so easy.... But talking online is sometimes really hard because you don't know whether the person's being sarcastic or what emotion they have. You don't have their tone of voice. And when they don't answer you right away you don't know if they're thinking about what you said, or off talking to someone else and just ignoring you. So I'm always checking, and saying 'Are you serious in saying that or are you just kidding?' And I try not to worry if someone doesn't answer me — they could have just been bumped off by AOL."*

At least three IM users had problems managing windows, keeping track of messages, and responding to the right people. Darla said, "The windows change when someone sends you a message, so sometimes I'll be typing along and hit return and all of a sudden I sent the message to the wrong person — it can be really awful, especially if you're talking about each other." Mike, talking to several friends at once, lost track of a window and message and had to type 'sorry didn't see u. ur behind another IM.'

Three other users have developed skills in using certain IM features to minimize these mistakes and confusions in communication.

> Renee, 13: *"I have a little technique. If there's more than one person online, I'll put their [windows] down here [on the task bar]. That way you can always tell because there's a little arrow, if they've said something, that appears here. You can tell who says what, but it still doesn't, like, clutter up your screen."*

Another literate practice we observed with IM occurred between two girls who habitually store and save IM chats that are significant to them — essentially archiving elements of a synchronous communication. They save the conversations by name, date, and topic, and they said that they would sometimes refer back to the conversations in order to resolve a conflict that had come up in the meantime.

Among the three children who were *not* regular IM users, Jasmine, 12, said the major barrier was her inability to type well. "Some of them type so fast!" she said. "I can't keep up with it. So I don't try." Phoebe, 13, explained that only one or two of her friends at school use IM, though she knows lots of other kids use it. By the end of the study, however, she was trying to install IM on her computer to talk to a growing number of friends online.

Email. Email is a distant second to Instant Messaging for this group. Nine out of ten children have their own email addresses, and seven check their mail at least once a week, but email use is

minimal compared to Instant Messaging. Email use appears to be more functional in nature than IM and chat, which are recreational. Children described emailing friends when they are not on IM, to ask them why they are not on. Three described sending homework assignments to each other. They receive email greetings and email "forwards" (of jokes and websites) from friends, and sometimes they reply or forward these to someone else they know. Only one child has no email address of her own, but borrows her father's account if she needs to send something.

Chat. Three children like to spend time talking in chat rooms, such as AOL Teen chats, MTV chats, and other teen chat rooms. This too is a form of recreation, and the skill that comes to the fore here is managing an "identity" among strangers, avoiding inappropriate people and advances, and interpreting information in people's profiles to form a picture of the conversational "other." Darla, 12, a girl who spends a great deal of her spare time on IM, is very fluent in the conventions of the medium, especially in finding out about her fellow-chatters by deciphering their profiles. Yet this form of literacy has its perils. It is easy (and tempting, apparently) in this medium for children to cross the line toward rudeness in language. Two boys were stripped of their AOL usernames for violating AOL's rules on appropriate language use in chat rooms (but were later reinstated with their parents' intervention), and Darla was observed in a long, taunting exchange with several other girls in a chat room, a type of conflict she likes to spark, she said, "just for the fun of it."

Bulletin boards. Finally, a last literate practice we noted was one boy's use of public bulletin boards as a place to absorb the knowledge of expert practitioners of his newfound hobby — building a robot. Entering the robots.com bulletin boards, Ben and his best friend were entering a social world of adults that was unfamiliar to them, and they had to observe the dialogue, decide how to make an initial foray in with their questions, and then gradually become recognized and welcomed as a peer bot-builder.

Discussion

Communication literacy is a fast-evolving area of the Greenville children's computer skills, driven by the large amount of time they spend in recreational chatting. In particular, the prevalence of Instant Messenger software in the community gives each child who has it access to a large network of peers to talk with. It is unclear to what extent children's online communications may be expanding their social networks — though children do report that they talk to friends-of-friends online (especially those of the opposite sex) whom they hesitate to talk to in person. Another exception is Cole, 13. As a home-schooled child he does not have access to a ready-made school network, so he uses IM and email a great deal, both to connect with the few home-schooled children who are scattered across town, and also to get to know school kids he might otherwise not know. Beyond this, two children are learning to engage with unknown others around shared interests, such as creating a website or building a machine. Three others are gaining experience in chat rooms talking to strangers, but these are transient communications.

Many of these children are becoming skilled at negotiating meaning with distant others in a text-only medium. We cannot predict whether the communication habits children are developing in their use of IM, email, and chat will transfer — for good or bad — to children's other, more academic and standard forms of writing, reading, and communicating. The two heaviest online communicators have poor spelling and syntax in *both* their academic writing and their online chatting. At the same time, four children we observed are able to *switch* rather easily between standard written English (as in an essay for school) and the highly abbreviated, coded, and non-standard syntax of IM and chat.

Web Literacy

Half of the Greenville children (five out of ten) are functionally literate in using the World Wide Web. They are able to conduct searches to find information they want, organize/store what they found well enough to return to it later, and keep in mind that web information and communication *might* be biased or untrue. Two of these children are also able to produce simple web materials, for example, by creating their own homepage using an AOL template. The remaining five Greenville children display greater fluency in using the web. In each area — searching, organizing files, judging bias, and authoring web information — they have an ability to use web tools well for their own individual goals.

All ten children use the web to find information for homework fairly regularly, but beyond this, they use their web literacy in very different ways. Of the seven children who browse the web regularly for recreation, three use it mostly to access *commercial media, entertainment, and shopping sites*, as well as chat sites. Darla is one of these children, as her list of favorite websites indicates.

> *Darla, 12: "Let's see, the sites I go to the most are AOL Teen Chat, Teen.com, MTV.com, Cantdodiddly.com, Z100.com — where I go to my favorite band sites, FoxKids.com, Jennifer Love Hewitt, Screamthemovie.com, Ebay.com — I like to browse all the stuff, Nsync.com."*

The four other children who browse the web for fun also enjoy commercial media sites, but they do something else in addition — they use the web *to pursue their own personal interests and hobbies* in such areas as music, writing, humor, videogame reviewing, robots, chess, books, language learning, sports, and photography. Eliza is one of these children, as her recitation of her bookmarks suggests.

> Eliza, 12: *"My favorite sites are, ok, Google.com first, 'cause that gets me to any of my interests: soccer websites; kids' writing websites; this songwriting site my teacher gave me; lyrics.com - I love lyrics, and singing along to.songs, and if I like a song I have to find out what the lyrics are; movie sites — I go to IMDB, the Internet Movie Database, to read about a movie when I want one to rent; MTV.com; perfectjoke.com; Mr.biology.home.att.net — that's my teacher's site; Bored.com; Cartoon dolls — that's a doll-making site; sites for TV actors I like; Internet Chess; quizzes on teen websites; sports sites — so I can get scores; The Importance of Being Earnest — a webpage with that play, I found it 'cause I love that play; Photography.com — that's my dad's photography webpage."*

Search Strategies. All ten children show some facility with at least one search tool, and nine of ten named several search engines that they have used. Half the children rely mostly on the search tools that appear on their service provider's homepage — AOL Search (3) or MSN Search (2). The other half choose from a range of search tools — Google, Yahooligans, Ask Jeeves, and ask.com. Five of the children also use the Napster's powerful search engine to locate copies of songs they like.

Six of ten children have basic or functional skill in using search tools — they can locate "good enough" information fairly quickly by some method they know — typing a word into the address box, followed by '.com', or typing search terms into a search engine and quickly browsing the top two or three sites. Still, they find the web a chaotic and sometimes overwhelming information environment, and seek ways to limit their encounter with it. The search engines they use — Google, Yahooligans, Ask Jeeves — organize and filter the web in various ways. Four of these children say they prefer using Encarta (a CD-ROM encyclopedia) to the web for most school assignments, because, for example, "it gives you better results for general topics."

Four children show more fluent use of search tools, mainly in the capacity to narrow and revise searches to better specify what they want. These children are untroubled by the chaos of the web — they move easily through it to the things that interest them. They have some understanding of the way a search engine works and the web is organized.

> Eliza, 12: *"[Using a search engine] is like a puzzle. The computer is dumb. It just looks for exactly the words you told it. So when you get back results, you can see more about what your topic is, and how you have to narrow down what you want. Be more specific. It makes you think about what it is you really want, and what you don't want."*

Ben, 13, figured out the trick of intentionally misspelling song titles or artists' names in the period after Napster blocked most artist names and song titles from its index. "You just have to realize that lots of people are terrible spellers when they type in their song titles — so when you misspell a name, chances are you'll get to a song somebody put in wrong."

Web evaluation. Five of seven regular web users indicated an awareness that a web source might be biased or not fully credible. Most often children raised the distinction between facts (which they consider trustworthy) and opinions (which they consider untrustworthy) — a distinction reinforced by their school library-media specialist, according to several.

> Jasmine, 12: *"I would say [a website] is good info if it has a lot of facts instead of opinions. And if it has a lot of stuff on the topic I'm looking for."*

Commercial bias was mentioned by only one child, echoing her mother's comments.

> Renee, 13: *"I never just browse the web — it's full of so many ads, it's a waste of time. I always go to sites I know, like Historychannel.com, or I use a search engine to find specific things."*

Finally, aided by talk with their parents (some of whom have vocal opinions), three children are developing a perspective on the value of the web as a whole:

> Eliza, 12: *"For information I'll go to the web instead of the library because the web is more recent. But if it's a book I want, or art, I won't download it, I'll go to the library. The web should be a tool, not the main thing."*

Web authoring. Two of the middle-income children created simple personal webpages using templates provided by AOL. These pages contain basic profile information, favorite websites, bands, and optionally, a picture. In both cases the information on them was out of date, and there were many misspellings, which did not trouble the authors since, as one said, "Hardly anyone goes to my page."

Three children went beyond this form of authoring and used the web as a way to publish their own thinking, writing, and artwork. Cole, 13, the home schooled boy, published his own website on his favorite videogames, hoping to attract the attention of the manufacturer; and also published his videogame reviews on other, bigger sites. Eliza, 12, submitted her poetry and drama writing to online children's writing sites, worked with an editor briefly, and saw two of her pieces published. Ben and his best friend posted 3-D drawings of their robot to a mock "company" website (created with the help of Ben's dad) to help their financial backers and friends see their progress.

Discussion

As with tool literacy, the middle-income children's web literacy shows two broadly divergent developments. About half of the recreational users (three of seven) use the web mostly to access commercial media, entertainment, and shopping sites, as well as chatrooms. The other half of the recreational users (four of seven) use it *to pursue a wide set of personal interests and hobbies.* These latter users, for the most part, display more nuanced search strategies, a more critical, evaluative stance toward the web, and are more likely than their peers to be involved in significant web authoring as well.

Two issues appear to bear on this distinction. One, discussed throughout this report, concerns the role of the school in fostering certain computing practices and skills. Two important aspects of web literacy — searching (using keyword searches) and evaluating the results of searching — are routinely taught by librarians in the Greenville schools. In addition, teachers in the high-track classes make more ambitious use of technology in their courses and in homework, assigning their students web quests, multimedia presentations, and posting their assignments and discussions on their own homepage — all of which likely contribute to higher levels of web literacy.

That said, it is important to acknowledge that the most literate and ambitious work done on the web by these children was driven by their *interests and passions*, not school assignments *per se*. (Ben, when asked how his robot project related to school, said immediately, "It doesn't relate at all"; indeed his interest originated with a popular TV show before being "scaffolded" by the web.)

The web, it appears, can powerfully fuel some children's interests and enthusiasms — if they are helped to recognize their interests and learn to take them seriously. In these middle-class families, some but not all parents do things to help children take their interests seriously. They find out what their children are interested in, they take them out in the world, they give them lessons. Some also monitor children's leisure activities such as TV watching, videogame playing, or chatting (and help them *self*-monitor), so they have *time* for both schoolwork and creative interests or hobbies. Where parents cannot do these things, of course, *teachers* may still be very important: Eliza, 12, and several of her peers described particular teachers — of science, of music — as influential figures who themselves fueled their interests and passions.

SUMMARY AND DISCUSSION

First, we briefly summarize our comparative findings in each dimension of literacy, and then we discuss why we believe these patterns have emerged.

- **Troubleshooting.** For troubleshooting, children in low-income households tend to rely on more formal networks (such as CFY and school teachers with technical skills), since they find few technical skills among their family, friends, and neighbors with whom they have close ties. In comparison, children in middle-income households tend to rely on their own troubleshooting skills, and also on parents, peers, and extended family members who have developed technical skills. Because most low-income families do not have credit cards (required by most Internet Service Providers), the primary technical problem faced by these families revolve around connectivity. This is not the case for middle-income families.

- **Purposes.** The purposes driving children's computing in low-income households are primarily school-related. In comparison, children's computing in middle-income households is focused first on communicating with peers, followed by game playing and hobbies, and then school-related tasks. For low-income children, recreational use of the computer brings the family together, often around activities that have cultural resonance. For middle-income children, recreational computing is often done alone. Finally, more than half of the low-income parents perceive their CFY computer as keeping their children home and off dangerous streets. This concern is not evident among middle-income parents, who live in safe suburban neighborhoods.

- **Common tools.** When it comes to common tools (word processing, email, search engines, etc.) children in both low- and middle-income households mainly use the surface-level features of the applications; however, about half the children in middle-income homes demonstrate fluency with more advanced features of these applications. The low- and middle-income children have developed their greatest aptitude with Microsoft Word. In the low-income households, the children are often more knowledgeable about computing than their parents. This is not the case in the middle-income homes.

- **Communications literacy.** The communications literacy of children in low-income households centers around email, while children in middle-income households engage with a range of communication tools—primarily Instant Messaging, but also email, chat rooms, and bulletin boards.

- **Web literacy.** Children in the low- and middle-income households have developed basic web search and file management strategies. About half the children in the middle-income households demonstrate basic web authoring abilities as well as an understanding of how search tools work and the web environment is organized.

Table 2. Summary of Comparative Findings: Literacy Skills That Are Paramount in Each Community

COMPONENTS OF LITERACY	PARTICIPANTS	
	Low-income children	**Middle-income children**
Troubleshooting	Use professional help providers	Use self, parents, peers, extended family
Purposes	School-related purposes	Communication with peers
Tool Use	Surface-level fluency	Fluency with surface-level and advanced features
Communication Literacy	Email	Instant messaging, email, chat rooms, bulletin boards
Web Literacy	Basic web search & file management	Basic web search, file management, Evaluation and authoring

How should we interpret and compare the findings we observed in low- and middle-income homes? How do we explain differences not only between the cohorts (middle-income families and low-income families) but also within them?

In each community we found that children's digital literacies are emerging in ways that reflect their local circumstances. Children's home computing practices were strongly influenced by three factors: 1) the technological environment, 2) the social environment, and 3) the school environment. In each of these areas there are challenges that deserve to be addressed by policies and programs; recommendations that address these challenges follow.

The Technological Environment as a Factor

Our findings suggest that the technological environment of low-income households may differ substantially from the environment in middle-income homes, even when both appear to have "computer and Internet access." First, in the middle-income homes computers were present for several years, whereas in the low-income homes they were present for only one year or less. Second, in the middle-income homes, parents had credit cards with which to purchase stable Internet connectivity via a major ISP such as AOL. In the low-income homes, parents often did not have credit cards (nor bank accounts in some instances), and were unable to purchase Internet connectivity from a major ISP. Instead CFY provided these families either with a local ISP that would accept payment through money orders, or an advertisement-supported "free" ISP. While the "free" ISP is a better solution for these families, none of them experienced connectivity that is as stable as the middle-income families'. Third, in the middle-income homes, there were multiple computers located in different places in the home, whereas in the low-income homes, there was one computer, often located in a heavily trafficked area (such as the living room or kitchen).

How does the number of computers within the home affect their use? Unexpectedly, we found that the relative *abundance* of computing resources in the middle-income homes sometimes leads

family members both to use them in more *isolated* ways, and to devote themselves more to entertainment, rather than educational uses. Computers were sometimes located in private places such as bedrooms, for example, and their fast speed and multimedia features led children to interpret them as more akin to television, the telephone, and videogames than typewriters, encyclopedias, or sketchpads, for example. At the same time, the relative *scarcity* of computing resources in the low-income households often led to family togetherness, as children and parents made a virtue of necessity and gathered around the computer in common activities, such as finding Spanish-language songs or hymns. Some parents, in fact, developed schedules and rules to avoid sibling conflict over the one computer. Thus, beyond a certain point, increases in home computing resources may have something of a centripetal effect: as family members have and use more of them, family members may pull apart from interactions with one another, even as they increase interactions with those outside the home.

Our findings also indicate that the location of the computer within the home may affect how it is used. When parents in either cohort placed a computer in a more "public" spot (often because they want to be able to monitor their children's computer use), this often led to more "interactive" family computing.

The Social Environment as a Factor

We found five elements of children's social environment that shape their computing in important ways: 1) parents' attitudes toward computer use; 2) parents' own experience and skills with computers; 3) children's leisure time at home; 4) the computing habits of children's peers; and 5) the technology expertise of friends, relatives, and neighbors.

First, parents' attitudes toward computer use significantly influence children's computing. Parents in both communities were very supportive of children's computer literacy. Most parents a) believed in the value of computing for children's success in school; b) created rules around computing that, for example, encouraged children to put homework before fun; and c) believed that children were at some risk using the Internet, and so tried to monitor children's time as best they could. In low-income households, parents perceived their CFY computer as keeping their children home and off dangerous streets. For some parents, safety became a recurring theme in our discussions with them. This concern was not shared by the middle-income parents in this study, who live in safe suburban neighborhoods. Parents in both communities also made substantial investments in new software and peripherals that enhanced their children's literacy development.

Second, parents' computer skills influence their children's computing. Greenville parents, with their considerable knowledge of computers and the Internet gained from jobs and from educational experiences, were better able to support their children's computing than those in Southchester and Eastside Heights. Greenville parents played active roles in troubleshooting problems and also modeled rich and varied uses of the computer for their children. Some but not all parents in Greenville shaped their children's computing by developing a "critical discourse" about computers and the Internet — discussing their strengths and their limitations with children regularly, and encouraging them to voice their own thoughts and ideas about this. While Southchester and

Eastside Heights parents brought less computer knowledge to the table, they did bring cultural interests and needs that shaped children's computing; for example, they asked children to help them find Spanish-language songs on the web and to type prayers that were important to them.

Third, children's leisure time differs in these two communities in ways that have impact on their computing. Greenville children spend a far greater amount of time at home after school without adult supervision than do the Southchester children attending ASE, most of whom arrive home after 6 p.m. because of an extended school day. As a result, Greenville children face choices about how to use their afterschool time at home that ASE children do not. Yolanda, our one low-income child from PAC, arrived home around the same time as the Greenville children and displayed similar patterns of computer use as the Greenville children, thus demonstrating that leisure time, not just income level, may be a stronger predictor of how children use their home computer.

Fourth, children's computing appears sensitive to the immediate peer contexts in which children are immersed. What kids do with a computer depends to a large extent on what a critical mass of their friends are doing. Most children in Greenville use Instant Messenger every day to talk to their friends online — a phenomenon related to the high proportion of children using IM software (made easily available to AOL subscribers). On meeting each other for the first time, these children routinely exchange IM screen names and add them to their buddy lists. Instant Messenger thus functions as a nearly 24-hour social circle, in which *someone* is almost always available to chat. CFY's strategy of wiring an *entire school community* with home computers holds promise for the development of similar peer cultures of computing; while the program does not promote Instant Messaging and chat software (viewing these activities as less integral to its mission), the participating children are all online, and thus are beginning to find these resources on their own.

Fifth, family and neighborhood social networks play a role in children's computing, particularly in troubleshooting. In the Greenville households, family members often turned for help to uncles, sister-in-laws, and cousins, and sometimes neighbors, who had rich funds of technology experience and knowledge. Children and families in Southchester and Eastside Heights did not find such funds of knowledge in their immediate social networks, and so turned instead to school teachers and to CFY. At least until they are able to build up some technical capacity themselves, low-income communities need organizations like CFY to provide crucial technical support.

The School as a Factor

Although school computing was not a focus of this study, it appears that schools in both communities helped shape children's home computing — chiefly through homework assignments; the direct instruction they provided; and the school schedule (as described above). In addition, parents subscribe strongly to the notion of school as the framer of home computing for their children.

The CFY children obtained some computer and Internet training from their schools (in addition to CFY training). At ASE Academy, they did not have a full-time technology teacher during the time

of this study. The science teacher took it upon himself, however, to provide instruction on software such as MS Word and on using the Internet. He also routinely assigned homework that required his students to do Internet research (defined as primarily information search and retrieval). Furthermore, to promote the use of home computers, other teachers gave extra credit points to students if their research report was typed. The one student from PAC had a full-time technology teacher, who uses a project-based approach in her computer instruction. Every student at PAC is enrolled in her computer class and thus engaged in variety of well-integrated computer and Internet activities.

In the Greenville middle schools, all students had group computer instruction from the library-media specialists, and this created a baseline of web literacy. Students were taught how to use search engines to find information on the web and how to evaluate the information they found. (This instruction appeared to be effective for about half of the children, who could furnish their criteria for judging information, e.g., "It's facts, instead of just opinions.")

School assignments in the Greenville schools differed in high-track and middle-track classes in ways that have consequences for children's literacies. High-track assignments called for more in depth, inquiry-based, and thinking work in web quests, stock simulations, and debate preparation. Middle-track assignments, like the low-income schools, called more for information search and retrieval skills, somewhat.

In sum, schools seem to play a major role in helping low-income children do rich computing; conversely, computers have the potential to play major roles in fostering closer communication and collaboration between school staff and families. For example, PAC uses the technology to engage families actively in their children's schooling. The school maintains email addresses for all students and teachers, and teachers often send homework assignments via email. In general, the schools in our study do not appear to be aware of their potentially powerful role in fostering children's computing literacies.

RECOMMENDATIONS

Based on our findings, we believe that policymakers and private funders can do a number of things to support children's computing and their acquisition of digital literacies. They can, for example:

- Fund programs that provide low-income families with home computers and the skills to use them. Our research involving CFY has demonstrated that home computers help children develop digital literacy. The low-income children in this study used their home computers primarily for schoolwork, unlike their middle-income peers who used their home computers first for communicating with friends, followed by game playing, then hobbies, and then schoolwork.

- Encourage home computer programs to train parents, not just children, in "computer literacy." This training needs to do more than teach adults to turn computers on and run specific programs. It should also: 1) show them practical uses of the computer for purposes *they* have interest in; 2) provide bookmarks or a website with information resources they want and need; 3) give people practice in troubleshooting computer problems, including how to recognize and talk about the key *functions* of computers and their peripherals — connectivity, communication, information navigation. CFY covers these topics during their half-day training sessions. They teach adults how to turn computers on and run specific programs. They also show adults websites *they* have interest in through their web-based scavenger hunt of the Community Corner website (www.communitycorner.org). Sites include foreign newspapers, Section VIII housing, GED training, and job postings. Funders and policymakers might also want to encourage home computer programs to involve parents as peer trainers and coaches during training sessions.

- Insist that home computer programs not only provide technical support to the communities they serve, but also help communities build their own troubleshooting literacy. CFY Tech Helper program strives for precisely this goal. The program trains two students from each school in computer repair and troubleshooting. The two students then provide technical help at the school, thereby strengthening students' informal networks for technical support and building the local capacity.

- Help schools become aware of the significant roles they play in children's computing — especially in low- and moderate-support families. For example, school assignments can make richer use of computers, replacing repetitive, basic mechanical uses like typing and fact-hunting with inquiry-tasks for which students use computers to research, design, and test ideas and problems they care about. CFY began incorporating teacher training into its program over the past year. CFY meets with teachers on staff development days and discusses homework assignments that can help students make better use of their computers. CFY also shares the best practices of teachers across their school sites.

- Support schools in using computing tools to strengthen family-school connections. One example would be encouraging school districts to use their E-rate funding to purchase communications software so that parents, teachers, and students can email one another. Another example would be to make resources available for teacher training once the communications software is installed so that teachers can leverage this new opportunity.

- Fund programs that help parents understand more about how they can keep their children safe online. This training should introduce software filters and also teach parents how to initiate discussions with their children about unproductive or risky online behaviors.

- Support research and programs that can help families in low-income communities maintain consistent Internet connectivity. While this study has shown that inconsistent Internet connectivity relates to both family finance (the ability to get a credit card) and software conflicts there is still more to learn. Policymakers should be made aware that most low-income families have no credit cards, whereas most Internet Service Providers (ISPs) require a credit card number for monthly billing purposes.

- Help replicate the CFY model of providing all students and teachers in a school with home computers and comprehensive services. Serving a *community* of children, rather than serving them one by one, appears to result in increased digital literacy, especially those literacies that relate to communications and the Internet. It also enables teachers to assign homework requiring a computer, since all teachers know that every student has the tools at home to complete the assignment.

- Fund additional research on the development of digital literacy among low-income children, particularly on the roles that schools can play in stimulating richer and more varied home computing through assignments, and the impact of family resources (the social and cultural capital available to children) on children's technology use at home. In this way we can understand better how schools and families leverage the home computing resources that children may have. This study suggests that social and material resources available in families, schools and communities shape children's digital literacies in important ways, but much more work is needed in this area.

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APPENDIX

The Academy for Scholastic Excellence (ASE). The ASE Academy, a college preparatory middle school located in Southchester, serves children in grades 5 to 8. The ASE school day extends from 7:25 am to 5pm Monday through Thursday; 7:25am to 3pm on Fridays; and 9am to 1pm on Saturdays. Hence, ASE students spend most of their daylight and waking hours at school. Tisha's mother, Michelle commented:

> *"The KIPP academy is a very long program. They go to school from 7:25 in the morning until 5 each day, and most times they stay till 6, in the computer lab, or in the gym. They go to school on Saturdays. It's pretty much regimented..."*

At the time CFY partnered with ASE, ASE was a public school. The following year (the year of this study), ASE became a public charter school. ASE is unusual in its focus on discipline, character, and a devotion to educating all children in a way that will prepare them for future college attendance. Children wear uniforms and regularly recite the five pillars of the ASE philosophy. One of these is "More Time" for academics. The children learn that: "There are no excuses. There are no shortcuts to success."

Middle-school-aged students apply for admission to ASE. When their child is accepted, parents are required to sign a contract promising to support their child academically.

ASE Academy did not have a dedicated technology teacher during the time of the study. However, the science teacher took it upon himself to provide instruction on software such as MS Word and on using the Internet. He also routinely assigned homework requiring his students to do Internet research. To promote the use of home computers, other teachers gave extra credit points to students if their research reports were typed.

The Power through Arts and Community (PAC) School. PAC is located in Eastside Heights and serves students in grades 7 and 8. It is a small, public middle school within a building that also houses four other small schools. The administration and staff at PAC are committed to providing students with an education that develops and supports both their creativity and cognitive growth. In most classes, teachers make an effort to combine art projects with academic instruction. For example, during the time of the study, PAC students wrote and produced an opera. In collaboration with the Metropolitan Opera Guild, the students worked in their English classes to create the script and song lyrics. In their art classes and after school, they created the set and costumes for the opera. The opera was performed before a full house in June 2001.

There is a dedicated technology teacher at PAC, and every student is enrolled in a computer class. Collaborating with a science teacher and an artist, the technology teacher uses a project-based approach in her computer instruction. For instance, eighth-grade students learn to use graphics software and word-processing programs in the context of creating a business identity for themselves (e.g., a logo, slogan, and business plan). Students also create web pages and Claymation animations. During the time of the study, students created their own books — adaptations of

Shakespeare plays — in conjunction with a project in their English class.

At PAC, staff and students also use the FirstClass e-mail system that was provided by CFY and their district. Each teacher maintains a "folder" (similar to a bulletin board) on the system to post homework assignments. Special project folders, such as a Harry Potter Book Club, have also been set up, and students can contribute regularly to both from home.

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